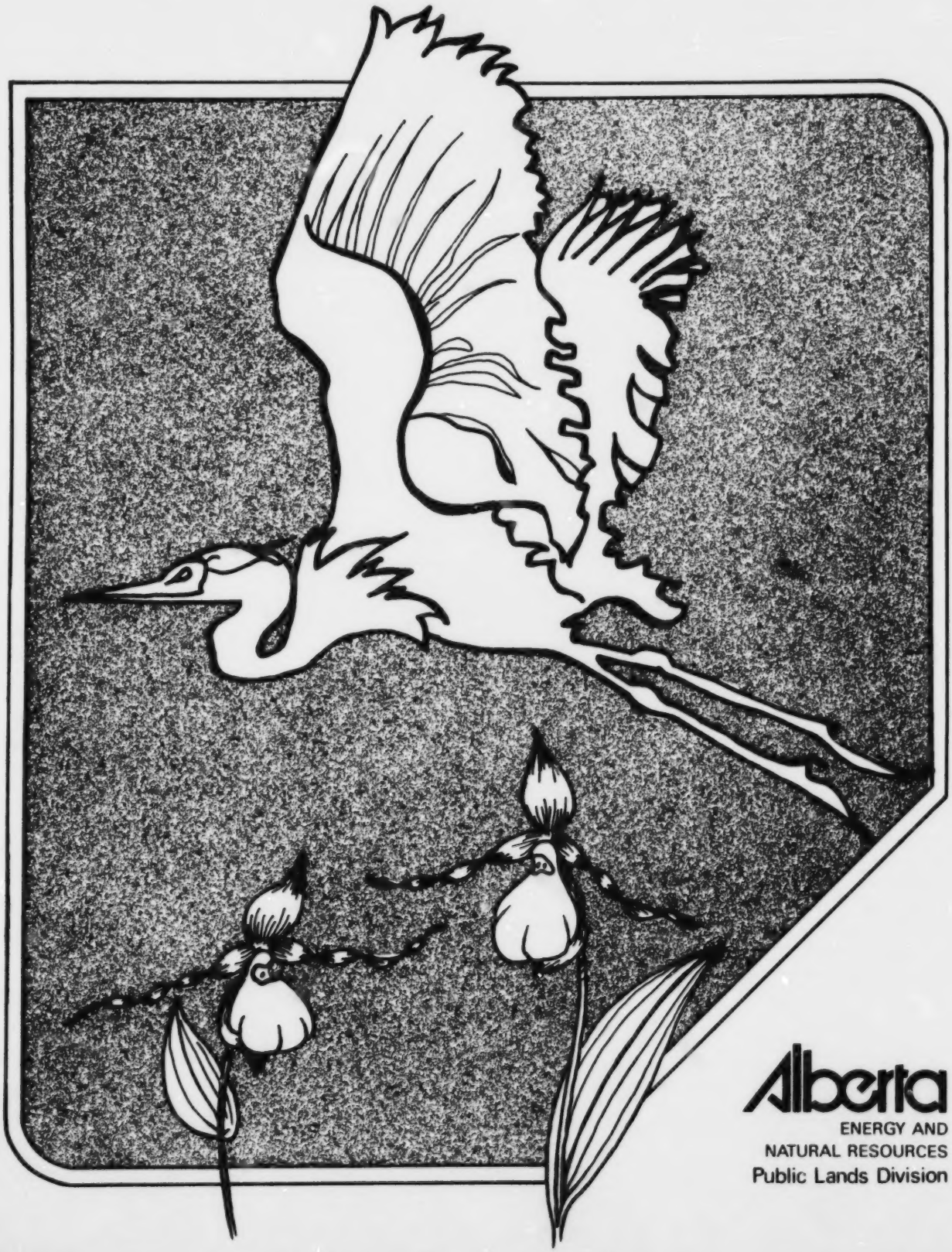
SEE
FOLLOWING
NOTE

VOIR
NOTE
CI-APRÈS

APPENDICES NUMBER 10 HAVE BEEN OMITTED FROM THIS FICHE BECAUSE THEY ARE OF POOR REPRODUCTIVE QUALITY

LES APPENDICES NUMÉRO 10 ONT ÉTÉ OMIS DE CETTE FICHE ÉTANT DONNÉ LEUR PIÈTRE QUALITÉ DE REPRODUCTION

CROW LAKE STUDY AREA-NORTHEASTERN ALBERTA
Biophysical Inventory



Alberta
ENERGY AND
NATURAL RESOURCES
Public Lands Division

CROW LAKE STUDY AREA

NORTHEASTERN ALBERTA

Biophysical Inventory

by

Daniel A. MacIsaac

1986
Edmonton

Alberta
FORESTRY, LANDS AND WILDLIFE
Public Lands Division

DISCLAIMER

The views and recommendations expressed in this report are those of the author and not necessarily those of the department.

ENR Technical Report Number: T/117
ISBN 0-86499-324-2

FOR ADDITIONAL COPIES OF THIS REPORT, CONTACT:

Information Centre
Alberta Forestry, Lands and Wildlife
Main Floor, Bramalea Building
9920 - 108 Street
EDMONTON, Alberta, Canada T5K 2M4
Telephone: (403) 427-3590

or

Natural Areas Program
Public Lands Division
Alberta Forestry, Lands and Wildlife
4th Floor, Petroleum Plaza, South Tower
9915 - 108 Street
EDMONTON, Alberta, Canada T5K 2C9
Telephone: (403) 427-5209

EXECUTIVE SUMMARY

This report summarizes a comprehensive biophysical study, including an inventory and description of the vegetation and special features of the Crow Lake study area, based on field work undertaken during the summer of 1983. This study was conducted so that the Crow Lake site can be compared with other sites in the Boreal Mixedwood Section.

The Crow Lake study area comprises 131 km^2 of land adjacent to Highway 63, 75 km north-northeast of Wandering River, Alberta. Crow Lake is the major water body in the area.

There are five terrain systems within the study area, and these can be grouped into one of two landscape types. The first is a slightly undulating upland plain in the east and south portions of the study area. The second is a more hilly area which composes the basin surrounding Crow Lake in the north and west sections of the study area.

The study area lies within the Boreal Mixedwood Section. Many of the vegetation types found in northeastern Alberta are represented. Approximately 69 per cent of the study area is upland forests, consisting of varying amounts of aspen, spruce and pine. Black spruce forests are the most extensive, covering 19 per cent of the study area.

Widespread treed black spruce peatlands occur in the south and east parts of the study site. There are smaller areas covered by poor fen, marsh and swamp vegetation.

Based on relevé data collected from 76 sampled stands, 16 upland and 12 wetland community types are identified.

Several special features have been identified in the study area. These include: eight plant species considered rare in Alberta, high diversity of plant community and habitat types, mature spruce - fir stands, possible peat palsas, a buried pre-historic campsite and rare bird species (bald eagle and osprey).

TABLE OF CONTENTS

		Page
1.	INTRODUCTION	1
2.	METHODS	4
	2.1 Land Use and Disturbance	4
	2.2 Geomorphology and Soils	4
	2.3 Fauna	5
	2.4 Flora	5
	2.5 Vegetation	6
	2.6 Special Features	7
3.	DESCRIPTION OF THE STUDY AREA	8
	3.1 Past Land Use	8
	3.1.1 History	8
	3.1.2 Administration	9
	3.2 Present Land Use	12
	3.2.1 Dispositions	12
	3.2.2 Land Use and Disturbances	18
	3.3 Potential Land Use	23
	3.4 Climate	26
	3.5 Bedrock and Surficial Geology	27
	3.6 Physiography and Drainage	30
	3.7 Soils	34
4.	TERRAIN SYSTEMS	39
	4.1 System I: Organic - Morainal Upland Complex	39
	4.2 System II: Valley Glaciofluvial	40
	4.3 System III: Upland Glaciofluvial - Organic Complex	40
	4.4 System IV: Glaciofluvial Channel	40
	4.5 System V: Dissected Moraine	41

Page

5. FAUNA 42

5.1 Avifauna 42
5.2 Ungulates 45
5.3 Furbearers 49
5.4 Small Rodents 53
5.5 Fish 54

6. FLORA 56

6.1 Composition 56
6.2 Significant Species 56

7. VEGETATION 58

7.1 General Description 58
7.2 Upland Vegetation 70
7.2.1 Coniferous Forest Unit 70
7.2.2 Deciduous Forest Unit 85
7.2.3 Mixedwood Forest Unit 89
7.2.4 Open Slope Unit 92
7.2.5 Upland Willow Unit 93
7.3 Wetland Vegetation 94
7.3.1 Open Treed Peatland Unit 94
7.3.2 Poor Fen Unit 102
7.3.3 Marsh Unit 107
7.3.4 Wet Meadow Unit 110
7.3.5 Swamp Unit 110
7.3.6 Miscellaneous Wetland Habitats 114
7.4 Vegetation of a Recent Burn 115

8. SPECIAL FEATURES 119

LIST OF APPENDICES

Appendix		Page
1.	List of Air Photos	123
2.	List of Maps	124
3.	Natural Areas Program Plant Community Data Sheet	127
4.	Subsurface Dispositions	129
5.	Wellsite Data	130
6.	Climate Normals for Stations Near Crow Lake (1951-1980)	
	6.1 Temperature and Precipitation	131
	6.2 Mean Wind Speed and Prevailing Direction	134
7.	Soil Profiles	135
	7.1 Brunisols	136
	7.2 Luvisols	139
	7.3 Gleysols	142
	7.4 Organics	143
8.	Annotated Lists	
	8.1 Vascular Plants	144
	8.2 Mosses and Liverworts	166
	8.3 Lichens	172
9.	Condensed Phase 3 Forest Inventory Data	174
10.	Detailed Stand Relevé Data for Surveyed Plant Communities	176

LIST OF FIGURES

Figure		Page
1.	Location of Study Area	2
2.	Crow Lake Study Area Boundary Modifications	11
3.	Gas Fields and Main Gas and Oil Pipelines in the Crow Lake Area	13
4.	Subsurface Land Dispositions	14
5.	Surface Land Dispositions	16
6.	Disturbances and Selected Land Use	19
7.	Land Capability for Recreation	21
8.	Soil Capability for Agriculture	24
9.	Land Capability for Forestry	25
10.	Geology of Crow Lake Area: Stratigraphic Column	28
11.	House River Watershed	32
12.	Drainage of Crow Lake Study Area	33
13.	Terrain Systems Classification and Soil Profile Location	35
14.	Selected Wildlife Observations	43
15.	Location of Plant Community Study Sites	59
16.	Location of Landform - Vegetation Cross-Sections	60
17.	Cross-Section Showing Landform - Vegetation Relationships: SSE to NNW	61
18.	Cross-Section Showing Landform - Vegetation Relationships: WNW to ESE	62
19.	Vegetation of Crow Lake Study Area 1:50 000	64
20.	Special Features of Crow Lake Study Area	120

LIST OF TABLES

Table		Page
1.	Avifauna Observations During Summer 1983	46
2.	Trapping Records for Study Area (1973-1982)	50
3.	Area of Major Vegetation Types: Comparison Between Crow Lake Study Area and Surrounding Region	63
4.	Coniferous Forest Types Along a Moisture Gradient	68
5.	Upland Plant Community Types	71
6.	Tree Mensuration Data for Canopy Species in Selected Plant Communities	74
7.	Wetland Plant Community Types	95
8.	Wetland Classification For Crow Lake Study Area	98
9.	Plant Species of Beaver Ponds and Dams	116

ACKNOWLEDGMENTS

I would like to thank the following people who helped in the field surveys and preparation of this report.

Peter Lee gave many useful guidelines and suggestions, assisted in the field, and reviewed portions of the text.

Sandra Myers and Monica Jackson provided field help.

Lorna Allen reviewed portions of the text.

Wayne Tedder lent his time generously to conduct the soils and terrain analysis and prepare the initial draft of those sections for the report.

Floral identification or verification was conducted by the following people for each plant group.

Lichens	-	Mike Ostafichuk
Mosses and Liverworts	-	Dr. Dale Vitt
Vascular Plants	-	Kathy Tannas

Pat McIsaac put in a lot of effort in editing and compiling the initial drafts.

John Rintoul did cartographic work on some of the figures and co-ordinated the final compilation of the report.

Special thanks go to my wife Linda, for the many hours spent editing and compiling data.

Also, Sylvain Charbonneau, my field assistant through most of the summer, deserves special mention for providing humour in the bush and sweating 'like a pig' in the line of duty.

1. INTRODUCTION

The mixedwood boreal forest in Canada is a large and significant forest region, stretching from southwestern Manitoba to northeastern British Columbia. About half of the area of this biogeographical zone occurs in Alberta, covering 290 000 km^2 (43.2 per cent) of the province (Strong and Leggat 1981). In Alberta, the Mixedwood Section of the Boreal Forest Natural Region lies to the north of the Aspen Parkland Region and Boreal Foothills Section and is bordered on the north by the Boreal Northlands Section. It is characterized by a forest association of varying mixtures of white birch (Betula papyrifera), white spruce (Picea glauca), balsam poplar (Populus balsamifera) and trembling aspen (Populus tremuloides), although the latter species is dominant in areal extent. The oldest stands tend to be composed of white spruce and balsam fir (Abies balsamea), while jack pine (Pinus banksiana) occurs on the drier, sandy upland sites. Black spruce (Picea mariana) is found on moister upland locations, and forms extensive peatland complexes on poorly-drained sites.

Although the mixedwood boreal forest is Alberta's largest natural section, there are few sites where there is protection from resource development. Indeed, there are several plant community types within this region that are being rapidly depleted (Fuller et al. 1970). According to a Government of Alberta position paper, Policy for Ecological Reserves in Alberta, "The objective of a system of ecological reserves is to preserve selected examples of the full range of Alberta's natural environmental diversity for the benefit of present and future generations". In light of the above, a 131 km^2 (51 sq.mi.) parcel of land around Crow Lake has been proposed for study as a possible ecological reserve to represent the major landscape - vegetation units within the Mixedwood Boreal Forest Section.

The Crow Lake Study Area is located 75 km north-northeast of Wandering River, Alberta at 55°47' North latitude, 112°10' West longitude (Figure 1). Highway 63 forms its western boundary. The legal land description of the site is as follows:

Twp. 78 - Rge. 14 - W4: Sec. 1-36

Twp. 78 - Rge. 15 - W4: Sec. 1, 12, 13, 24, 25, 36 (all E/highway)

Twp. 79 - Rge. 14 - W4: Sec. 1-12 (all E/highway)

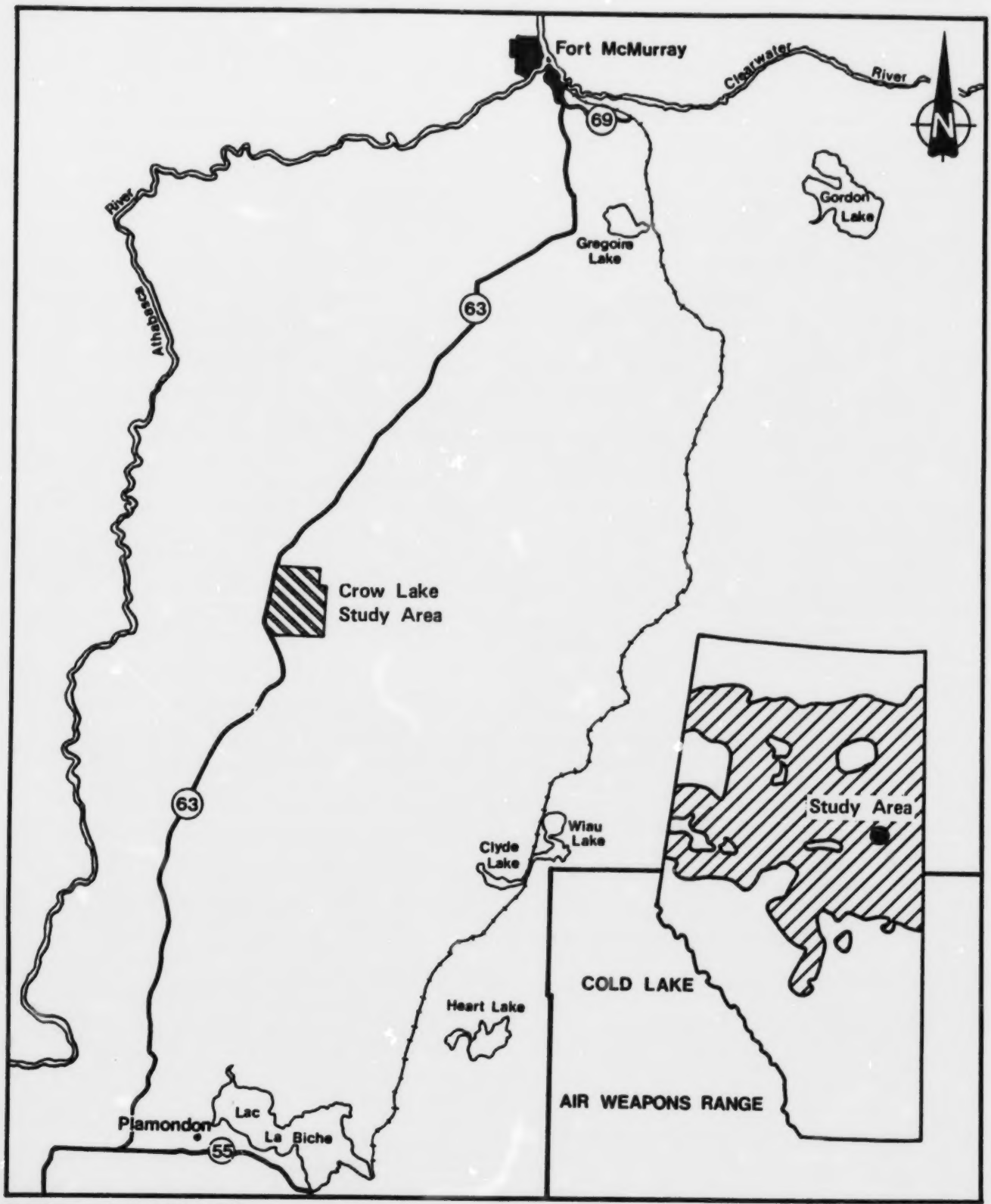


Figure 1. Location of Study Area

This report summarizes a comprehensive biophysical study, including an inventory and description of the vegetation and special features, of the Crow Lake Study Area, based on field work undertaken during the summer of 1983.

The reasons for this study are two-fold:

1) Impact on present land management decisions:
   Because of its proximity to a major highway and presence of a variety of resources in the region (recreational, forests, oil and gas), this area has received increasing and often conflicting land use demands. In order to accommodate legitimate land uses, baseline biophysical information is required.
2) Comparison with other potential reserves:
   Before the Crow Lake site can be rated against other candidate areas, a comprehensive summary of its biophysical resources is needed.

The study objectives were to:

1) Compile an annotated floral species list;
2) Describe and map the major plant communities;
3) Map the surficial geology and describe the soil types;
4) Compile species lists of the fauna;
5) Identify and describe special features;
6) Map man-made disturbances;
7) Conduct a literature search and incorporate it into the report.

2. METHODS

May 1983 was spent in the office conducting literature searches and undertaking logistical preparation for the field season. Although Crow Lake is located in an area where few specific ecological studies have been done as compared to more intensively studied areas to the north around the Athabasca Oil Sands and to the south in the Lac La Biche and Lakeland Districts, there is a variety of biophysical research information available. As well, recent aerial photograph and map coverage, at various scales, is available for the Crow Lake area (Appendix 1 and 2). Field work was conducted from late May through late July 1983. Data assembly and analysis commenced in August.

2.1 Land Use and Disturbance

Present land use was determined from the following sources:

1) Natural Areas Program files;
2) aerial photographs and maps;
3) field observations;
4) interviews with local trappers and recreational users;
5) records of surface dispositions.

Man-made disturbances were initially identified on air photos, field checked and then mapped at a scale of 1:60 000. This was supplemented by observations made during the field season.

2.2 Geomorphology and Soils

Prior to the field season, landform units were mapped by Wayne Tedder, Public Lands Division, Alberta Energy and Natural Resources, at a scale of 1:60 000 using air photos. Potential soil and substrate sampling sites were located within a wide variety of these landform types. From July 22-24, 1983 a reconnaissance field trip was undertaken to sample soils and substrate. Twenty-six sites were visited in the most accessible areas. Soil pits were dug to the C horizon in mineral soil and to a depth of 1.5 m in organic terrain. Soils were described using the Canadian System of Soil Classification (Canadian Soil Survey Committee 1978) and pH measurements taken in the

field. Based on the substrate and soil analysis, a broad level terrain system classification was described and mapped at a scale of 1:60 000.

2.3 Fauna

Information concerning the occurrence of fur bearing mammal species was derived from catch records of local trappers (Alberta. Fish and Wildlife Division n.d.). A summary of habitat use and distribution of major sport fish, small rodent, ungulate and fur bearing mammal species in the area was compiled from data from the Fish and Wildlife Division, Alberta Energy and Natural Resources, and from studies conducted as part of the Alberta Oil Sands Environmental Research Program (AOSERP). In June 1983 Natural Areas Program staff conducted an avifauna survey of the study area (Rintoul and Myers 1983) (Appendix 3). Information on wildlife observed and identified during the course of 1983 summer field work is included in the report.

Nomenclature for mammal species follows Banfield (1974). Common and scientific names for birds follow Salt and Salt (1976). Names for fish species are from Scott and Crossman (1973).

2.4 Flora

An annotated floral list (excluding algae, epiphytes, fungi, and hornworts) was compiled for all species noted within the Crow Lake Study Area. A wide variety of habitats was surveyed throughout the field season so that both early and late flowering species would be recorded. General phenological observations (e.g., flowering date) and habitat information were recorded for the vascular species. The total number of sampled stands that a species was recorded in is noted on the annotated species list, as are additional species recorded in the study area by other workers but not found in the present study.

Exotic species growing within the study area boundaries along the east side of Highway 63 were not recorded; however, weedy species found on disturbed sites within the study area (e.g., along the winter road or seismic lines) were included in the species list.

Scientific nomenclature for the vascular species follows Moss (1959), and for mosses follows primarily Ireland et al. (1980) with some species determined from Crum et al. (1973). Scientific nomenclature for lichens is from Hale and Culberson (1970) and for liverworts follows Stotler and Crandall-Stotler (1977). Common names for vascular species are taken from Moss (1959), or from Looman and Best (1979) when there is no common name from the former source.

Plant voucher specimens were collected for verification and deposition in the herbaria of Alberta Energy and Natural Resources and the Provincial Museum of Alberta (PMAE). Species were considered rare for Alberta if listed by Argus and White (1978) or Packer and Bradley (1984). Rare species are defined as those restricted to a small area or as those which occur sparsely over a larger area in the province.

2.5 Vegetation

Broad scale vegetation community and landform types were initially delineated from 1:60 000 aerial photographs. Field reconnaissance in late May was conducted to determine access throughout the study area and to verify the small scale mapping units. Vegetation units were then delineated at a scale of 1:15 000 using Phase 3 Forest Inventory maps (Alberta. Alberta Forest Service 1983) and air photos. Initially, the Phase 3 data was condensed into a tabular form which listed community types found in each legal section based on forest canopy dominants. These tables were then used throughout the field season to ensure that all major community types were sampled. Homogenous stands were selected for sampling based on the following criteria: physiognomy and dominant species, reasonably uniform topography, slope, aspect and moisture status. Minimum stand size was two hectares, although in a few cases, where a particular habitat was limited in area, smaller stands were sampled.

Seventy-six stands were sampled using a relevé method which employs a standard community description form used by the Natural Areas Program (Appendix 4).

Within each stand, canopy cover was estimated for the following physiognomic strata:

1. Tree canopy I: woody species 5 m tall
2. Tree canopy II: woody species 5 m tall (distinguished if there was a distinct subcanopy)
3. Tall shrubs: woody species 2 m to 5 m tall
4. Low shrubs: woody species 0.5 m to 2 m tall
5. Herb-dwarf shrubs: vascular species 0.5 m tall
6. Bryoid layer: lichens and mosses growing on the ground or on fallen logs

For each stratum the average height was estimated, and where applicable, diameter at breast height (dbh) and growth ring samples were obtained.

Canopy cover was estimated for each species in each stratum. Canopy cover was estimated on a percentage basis and follows Daubenmire's (1959) definition as the percentage of ground surface covered by a vertical projection of plant foliage. Thus, spaces in canopy are not included in cover estimates.

Epiphytes, algae, fungi and hornworts were not considered in this study.

Cover values were also estimated for the following surface components: rock, humus, mineral soil, deadfall, water and total unvegetated.

Landform description for each community followed the criteria outlined by the Canada Soil Survey Committee (1978). As well, elevation above sea level (ASL), slope, aspect, moisture regime, drainage, site position, vegetation stability (change over time) and microtopography were noted, based on the Province of British Columbia Ministry of Environment classification system (Walmsley et al. 1980).

At least one sample stand was surveyed for each community type identified. For most community types, duplicate stands were sampled, where time and logistics permitted.

The plant communities were classified using the method outlined by Lacate (1969) in which the vegetation was sampled first and then classified into community types. The classification was done on the basis of physiognomy, species composition and species abundance, by visual comparison of the data between sampled stands.

A medium scale vegetation map was compiled using the field surveys, 1:15 000 air photos and Phase 3 Forest Inventory maps. Mapping was done at a scale of 1:50 000 (later reduced to approximately 1:67 000 for inclusion in the report) with vegetation types based on physiognomy and canopy dominants. The areal extent within the study area of each forest community was determined using the computerized forest inventory data available from the Timber Management Branch, Alberta Forest Service, Alberta Energy and Natural Resources.

2.6 Special Features

Plants, animals, habitat types, plant communities, landforms and human artifacts were all considered when identifying special features. Features considered as special were those that were rare, uncommon or had specific significance in relation to the Boreal Mixedwood Section or occurred only rarely within the boundaries of the study area. These features were identified throughout the course of the field work and were then mapped.

3. DESCRIPTION OF THE STUDY AREA

3.1 Past Land Use

3.1.1 History

Archaeological evidence suggests that this area has been continuously occupied by humans since the wasting of the Laurentide Ice Sheet at approximately 10 000 B.P. The original inhabitants existed in a hunter-gatherer economy, subsisting on big game such as moose (Alces alces), but relying more heavily on fish as a staple food source (McCullough 1982). Consequently, the native population tended to live along the streams, rivers and lakes in the region. Data from Alberta Archaeological Survey supports this hypothesis (Pollock 1977). A "mootsigan ground" or ancient gathering place has been identified along the House River, two kilometres south of the study area. At Crow Lake, within the study area, a buried campsite has been unearthed on an upper level terrace overlooking the northeast end of the lake and there is high potential for other finds around the lake (Pollock 1977).

The Beaver Indians inhabited the area until the late 1700s at which time they were displaced to the south and west by the Woodland Cree Tribes. The Cree were being driven from their hunting grounds to the east by the heavy trapping of the North American fur trade. By 1800 the fur trade had expanded into the region, and trapping probably occurred throughout the study area (Chalmers 1974b).

The area was bypassed by major transportation routes until very recently. Once pockets of settlement began to spring up throughout the north, the major travel route was by river, along the Athabasca, some 30 km to the west. A rail line was opened to Fort McMurray in 1925, but did not affect the area as the route was over 70 km to the east of Crow Lake (James 1980). Only a low-grade forestry winter road passed through the study area.

The traditional land uses of hunting and trapping did not change until the mid-1960s when the development of the oil sands near Fort McMurray necessitated the building of adequate highway access to the north. The route, chosen in 1963 from ground and air surveys, followed neither the traditional Athabasca River route, nor the existing railway line. Instead, the highland area in between was chosen, which meant that the proposed highway right-of-way was adjacent to the study area. During the winter of 1963-64, the section of new all-weather gravel highway passing by Crow Lake was completed (Chalmers

1974a). This road, passing within 0.5 kilometres of the lake has radically changed land use in the area.

3.1.2 Administration

In 1968 the Alberta CT Consulting Panel (CTP) of the International Biological Programme (IBP) was created. Its primary objective was to initiate a provincial inventory of natural ecosystems in order to determine which types were adequately protected, and which ones needed protection (La Roi and Babb 1974). As such, the panel worked closely with the Natural Areas Committee (NAC) of the Alberta Department of Lands and Forests which had been created in 1967 to establish a provincial program of natural areas.

In July of 1969, IBP staff working out of the Department of Botany, University of Alberta, conducted a vegetation survey along Highway 63 from south of Wandering River to Fort McMurray. Based on this preliminary reconnaissance, they proposed that the CTP recommend to the Natural Areas Committee that the Crow Lake area be considered as a candidate for a major ecological reserve to represent the Boreal Mixedwood Section.

On April 16, 1970 the CTP passed on this proposal to the Natural Areas Committee, offering the following as justification for the creation of a Crow Lake Ecological Reserve (Laidlaw and Hnatiuk 1969):

1. Diversity of communities
   The site includes representative examples of most of the habitat and community types of the Boreal Mixedwood Forest in east-central Alberta (i.e. aspen - spruce - balsam fir - jack pine mixedwood), aspen and balsam poplar forest, jack pine forest, spruce - balsam fir - feathermoss forest, black spruce peatland, willow (Salix spp.) - swamp birch (Betula pumila var. glandulifera) scrub, sedge (Carex spp.) peatland, and several lakes together with associate aquatic and semi-aquatic communities.
2. Need for preservation
   Many of the community types present at Crow Lake are decreasing rapidly in the province and steps should be taken to preserve representative samples of them.
3. Lack of similar areas
   The only substantial boreal forest area in Alberta which is protected at present from resource development is in Wood Buffalo National Park, far to the north, in a different climatic and vegetation section.
4. Ease of access
   Good access to the site is provided by Highway 63 which runs along the western margin of the proposed reserve; a forestry winter road passes through the center of the area.

5. Absence of disturbance

The area is crossed by only two seismic lines; an oil pipeline passes through the area but is confined to a 30-50 m swath through the forest, adjacent to the highway. There are no logging or pulp cutting operations in the area.

The CTP suggested that the reserve encompass 131 km^2 (51 sq.mi.) and include the following lands (Figure 2):

Twp. 78 - Rge. 14 - W4:	All sections
Twp. 79 - Rge. 14 - W4:	Sec. 1-12 (E/highway)
Twp. 78 - Rge. 15 - W4:	Sec. 1, 12, 13, 24, 25, 36 (all E/highway)

At their November 18, 1969 meeting, the Natural Areas Committee discussed the possible creation of a Crow Lake Ecological Reserve. Although the site was not considered unique, it was seen as valuable because of the wide variety of vegetation it represented. For this reason a protective administrative designation was placed on the lands described above to retain them for conservation purposes. This designation has been in place since December 1970.

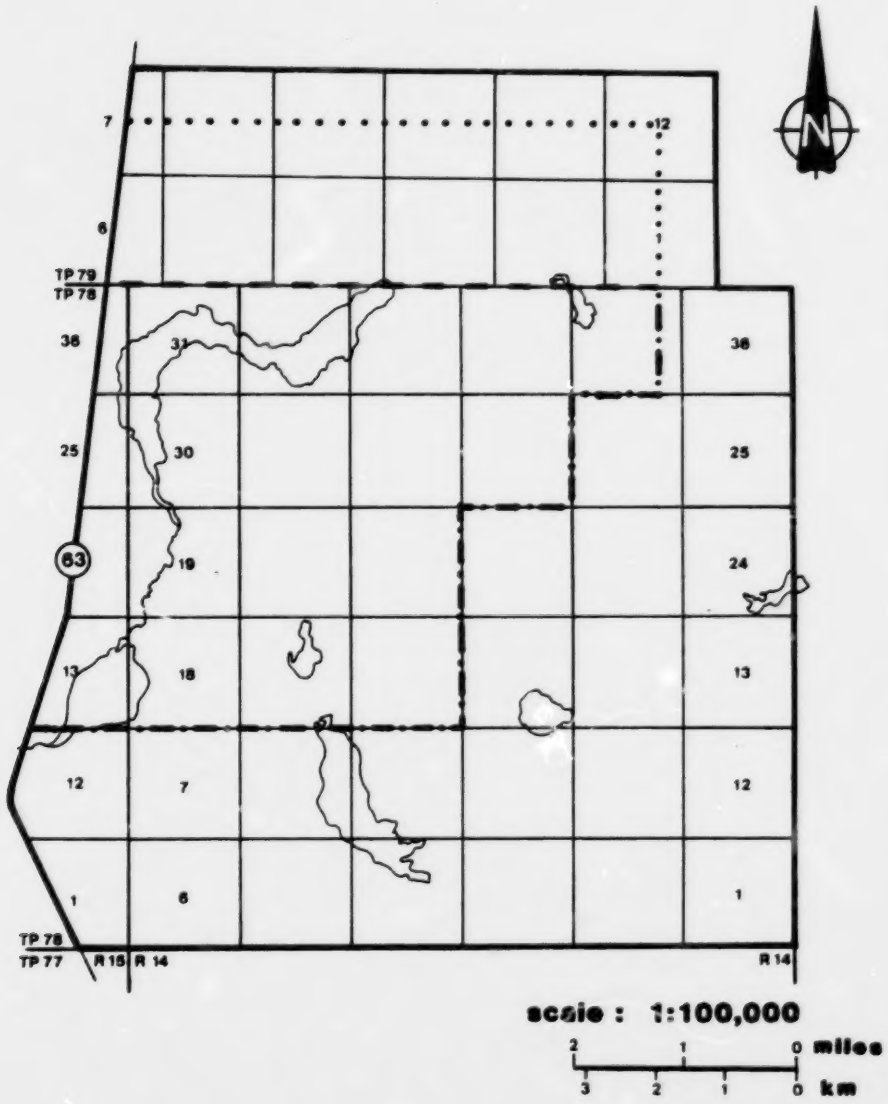
Since the initial 1969 CTP survey, field checks by several agencies have identified some significant features within the study area. Inventories by the Alberta Ecological Survey (Ellis and La Roi 1978) and later by Natural Areas Program staff (Lee et al. 1979) confirmed the presence of at least one mature white spruce - balsam fir stand adjacent to Crow Lake. Such old age communities are uncommon in the province, and selective cutting of such stands is reducing their occurrence even further (Achuff 1974). During the latter survey, several ecologically sensitive bird species [bald eagle (Haliaeetus leucocephalus) and osprey (Pandion haliaetus)] were observed nesting around Crow Lake. These findings increase the importance of Crow Lake as a possible ecological reserve.

In the fall of 1979, increasing oil and gas exploration activity in the area of Crow Lake led Alberta Provincial Parks (with the approval of the Natural Areas Program) to reduce the size of the core area being considered for ecological reserve purposes. About 72.5 km^2 (28 sq.mi.) were deleted leaving 60 km^2 (23 sq.mi.) with the following legal description (Figure 2):

Twp. 78 - Rge. 14 - W4:	Sec. 16-21, 27-34, W1/2 and LSDs 2-7, 10-15 of 35
Twp. 79 - Rge. 14 - W4:	Sec. 1 (W1/2), 2-5, 6 (E/highway), 7 (E/highway), S1/2 8, S1/2 9, S1/2 10, S1/2 11, SW 12
Twp. 78 - Rge. 15 - W4:	Sec. 13, 24, 25, 36 (all E/highway)

In January 1980 the core area under consideration for ecological reserve purposes was further modified to delete northern portions of the area which lie within an Oil Sands Lease (McMurray Zone). Core lands then considered were the following, for a total of

Figure 2. Crow Lake Study Area Boundary Modifications



LEGEND

—— ORIGINAL AREA PROPOSED FOR PROTECTION IN 1969 (PRESENT STUDY AREA)

····· CORE AREA PROPOSED 1979

– – – PRESENT CORE AREA (PROPOSED 1980)

(63) HIGHWAY

43 km^2 (16.6 sq.mi.) (Figure 2):

Twp. 78 - Rge. 14 - W4:	Sec. 16-21, 27-34, W1/2 and LSDs 2-7, 10-15 of 35
Twp. 78 - Rge. 15 - W4:	Sec. 13, 24, 25, 36 (all E/highway)

Since June 1983 the original 131 km^2 (51 sq.mi.) area has been administratively classed as having ecological reserve/wilderness area potential. This large area is considered in this report as two zones; a core area that is a prime candidate for an ecological reserve (boundaries follow the 1980 modification as outlined above) and a non-core area, which encompasses the original boundaries suggested by the CTP surveyors.

Even with successive reductions in core area size most of the major features which led to the original proposal for a major ecological reserve at Crow Lake are still represented. These features include: Crow Lake itself; the mixedwood stands surrounding the lake (including the mature spruce / fir stands); wetlands and examples of aquatic and semi-aquatic community types. The amount of major wetlands and open black spruce peatlands in the present core area is greatly reduced from that in the original site proposal. The inclusion of non-core area lands in the boundaries of a possible ecological reserve depends in part on whether suitable candidate areas can be found elsewhere in the boreal mixedwood forest to represent the wetland element.

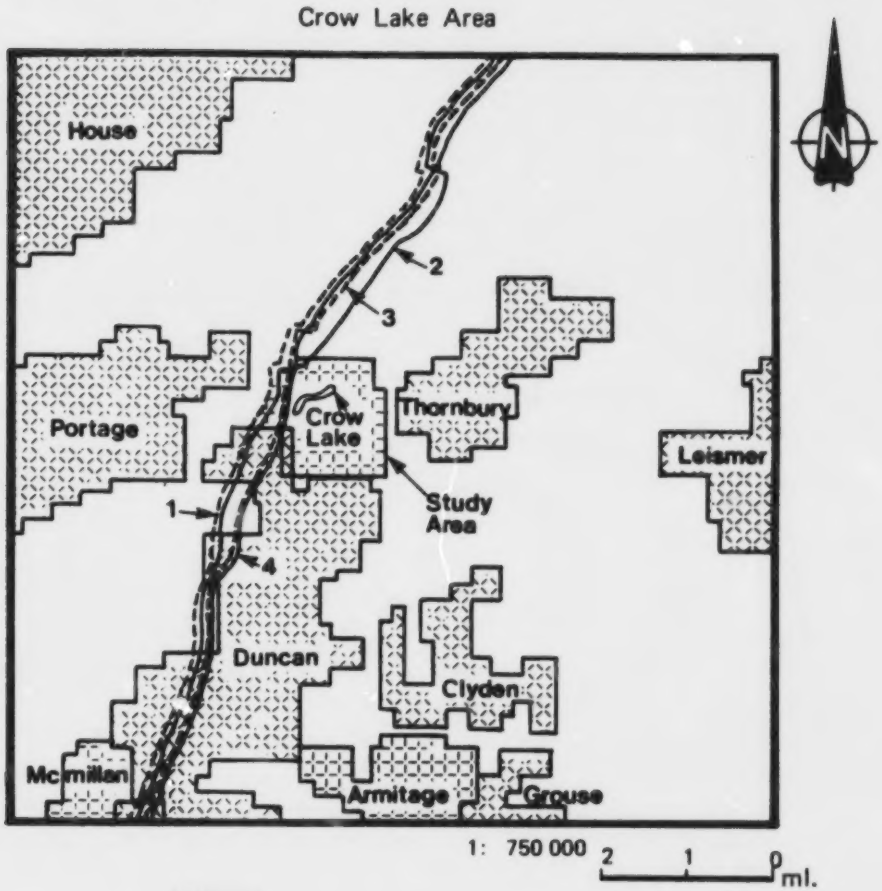
3.2 Present Land Use

3.2.1 Dispositions

The study area lies within a region where exploration for oil and gas deposits has been going on for the past 15 years. There are surface and subsurface petroleum and natural gas dispositions within the boundaries of the study area, as well as the associated land use disturbances (seismic lines and wellsites). The Energy Resources Conservation Board has identified several gas fields in the Crow Lake vicinity. The Thornbury field is two kilometres east of the study area, the Portage field lies approximately 10 km west of Crow Lake, and the Duncan field abuts the study area on the south and west (Figure 3). Within the study area, gas has been located in the Wabishaw Zone in two locations.

Subsurface Dispositions. Figure 4 depicts information concerning Petroleum and Natural Gas Leases and Oil Sands Leases which lie within the study area. Since 1980, based on the recommendation of the Natural

Figure 3 GAS FIELDS AND MAIN GAS AND OIL PIPELINES



LEGEND

Gas

Oil

PIPELINE	OPERATOR
1	Pelican Pipeline Ltd.
2	Alberta OilSands Pipeline Ltd.
3	Alberson Oil and Gas Ltd.
4	Suncor (Great Canadian Oil Sands Ltd.)

Gas Field

Study Area

Source: E.R.C.B. (Aug 1, 1983)

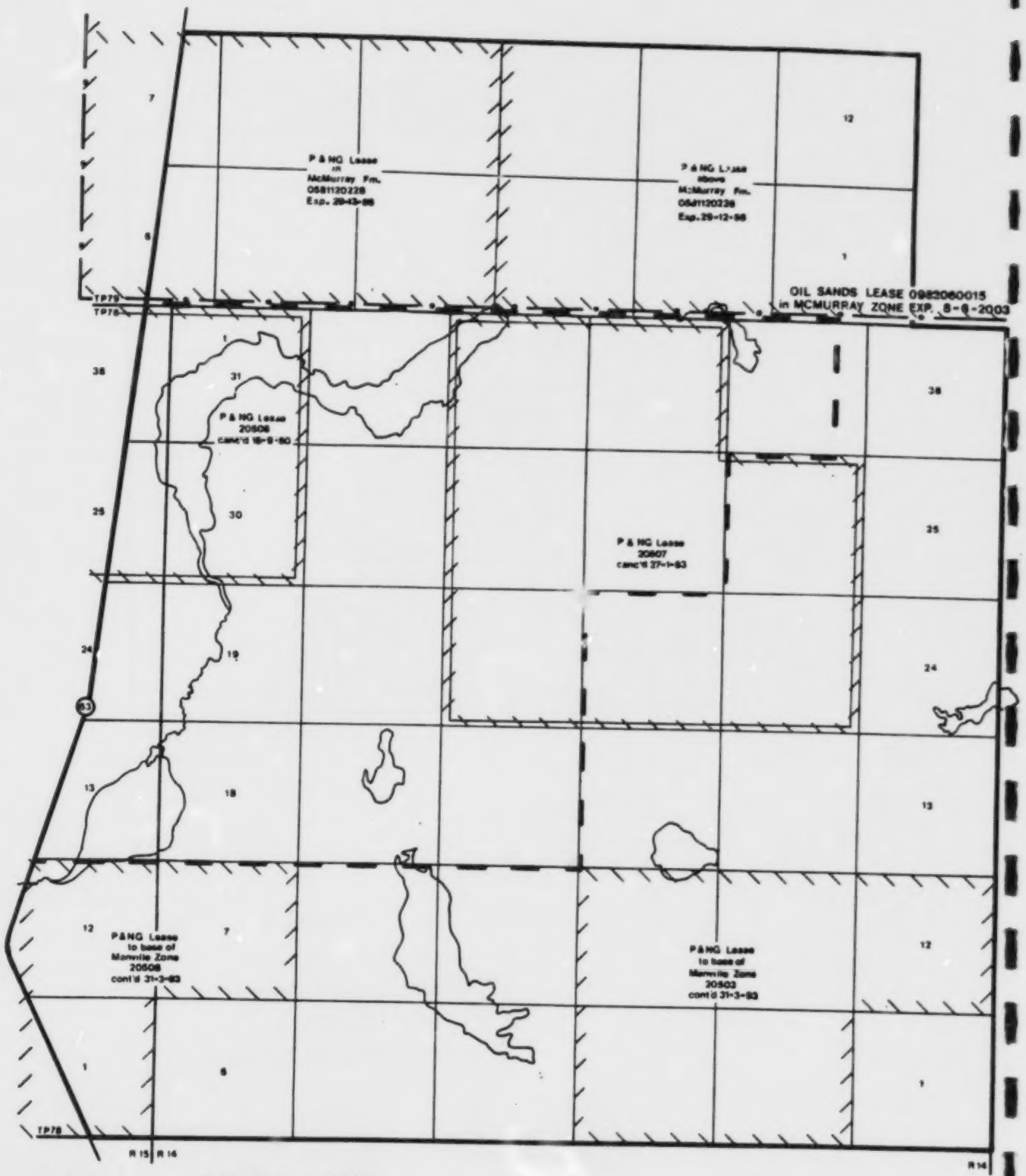


FIGURE 4 **CROW LAKE STUDY AREA**

SUBSURFACE LAND DISPOSITIONS (AUG., 1983)

Study Area

Core Area

Miles 1 0 1

Km. 1 0 1

Areas Program staff, the study area has been considered as two zones with two sets of operating restrictions for holders of Petroleum and Natural Gas leases. Generally, surface access for gas exploration has not been granted in the core area due to the presence of Crow Lake, steep topography, and mature upland forests. Where surface access has been granted on leases that cross over into the core area, some or all of the following restrictions have applied: no base camp within the core area, use of existing seismic lines or the winter road for access, use of portable seismic equipment only, drilling only in winter and allowing only "step out" wells in the core area. When the core area is posted for Petroleum and Natural Gas leases, it is with the addendum that surface access may not be permitted. Surface access for hydrocarbon exploration is allowed (subject to Natural Areas Program approval) within the remainder of the study area which surrounds the core zone. To date, all wells have been drilled within this second area.

At present, there are no Petroleum and Natural Gas leases held within the core zone. Leases 20503 and 20506 cover areas in the south end of the study area and have recently been extended (Figure 4). Leases 0581120226 and 0581120228 cover the northern part of the study area in 79-14-W4 and are set to expire in 1986. Two leases (20507 and 20508) were located within the core area, but were cancelled in January 1983, due to the stringent operating conditions imposed on activities in that area. Crow Lake lies on the southern boundary of the McMurray Oil Sand area. The southern boundary of the long term Bituminous Oil Sand Lease lies to the north of Crow Lake, along the boundary between townships 78 and 79 (Figure 4). Appendix 5 lists data on the currently held subsurface dispositions.

Surface Dispositions. All of the core area and adjacent land within the study area is provincial Crown land administered by Alberta Energy and Natural Resources. All lands within the study area (except for parts of two quarter sections) are covered by a protective reservation for a potential ecological reserve with all dispositions to be referred to the Natural Areas Co-ordinator. A recreation reservation is held by the Alberta Forest Service on LS 12, Sec. 30-78-14-W4, pts. LS 9, 10, 15, 16, Sec. 25-78-15-W4 (east of highway and west of and adjacent to Crow Lake) for a primitive campsite (Figure 5).

Pipeline agreements have been issued to Alberta Oil Sand Pipeline Limited, Pelican Pipeline Limited, Suncor Inc. and Alberson Pipeline Limited for oil and gas lines that run adjacent to highway 63 in Sec. 6 and 7-79-14-W4 (Figures 3 and 5). Canadian Superior Oil Ltd. has been issued Licenses of Occupation (LOC) along seismic lines in the south and east portions for access to exploratory gas wells. In conjunction with this, Mineral Surface Leases (MSL) were awarded in January 1981 for three wells drilled in the area (Figure 5). Further information on wells drilled in the study area is found in Appendix 6.

The Wilderness Adventure Youth Society of Northeastern Alberta (WAYS) has held a recreation lease (770025) on a 10 ha site in LS 14,

Figure 5

SURFACE LAND DISPOSITIONS

LEGEND

LOC	License of Occupation
⊕	Gas Well - abandoned
⊙	Observation Well
⦶	Gas Well - drilling suspended
MSL	Mineral Surface Lease
GL	General Lands File
RECLS	Recreation Lease by W.A.Y.S.
⬟	Cabin
DFRS	Recreation Lease - Alberta Forest Service
—·—·	Oil Pipeline
—··—··	Gas Pipeline
— — — —	Seismic Line
= = = = = =	Forestry Winter Road

NOTE: All areas are under a PNT 0331/3/710,730 reservation.

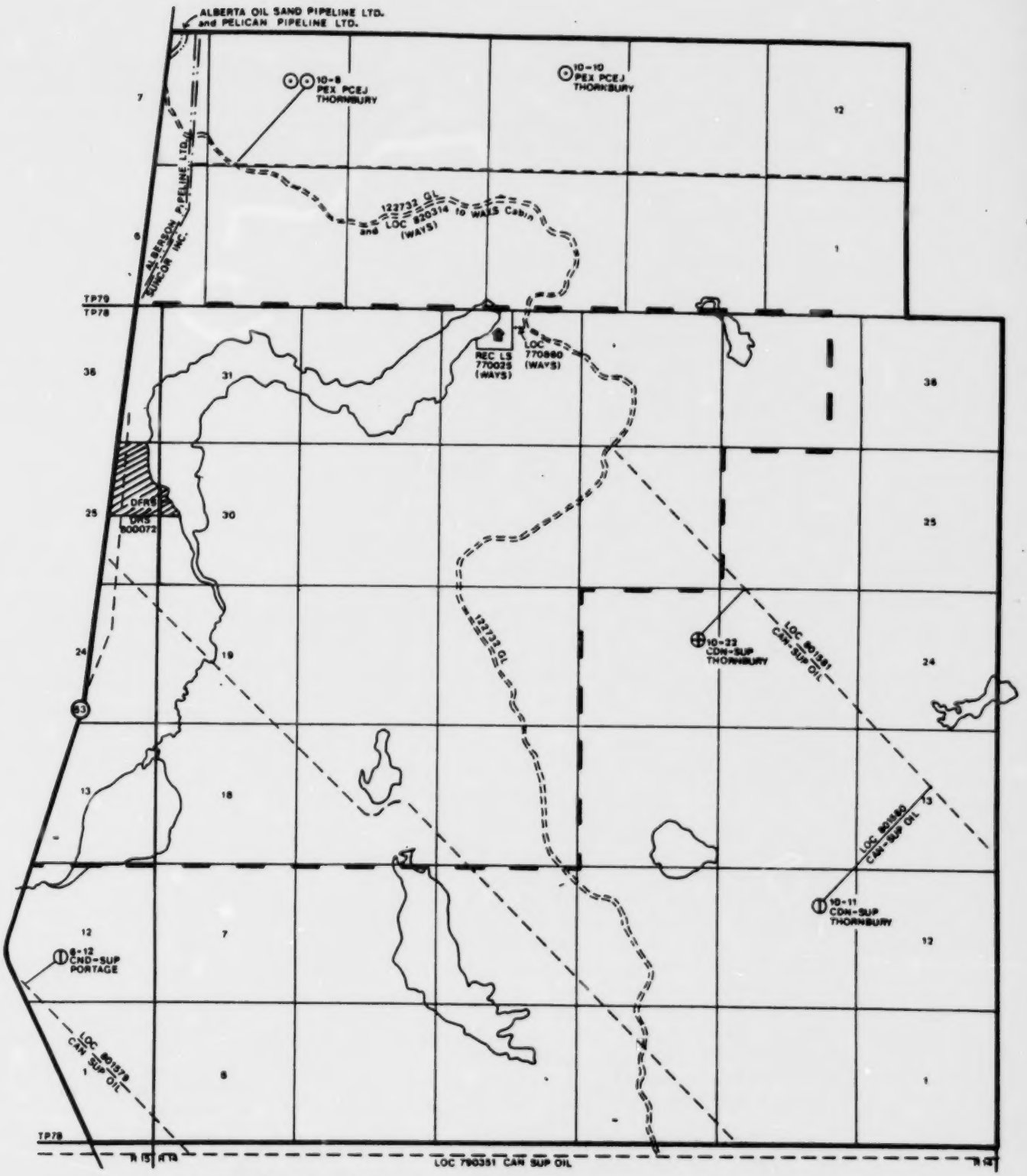


FIGURE 5 **CROW LAKE STUDY AREA**

SURFACE LAND DISPOSITIONS (Aug. 31, 1983)

Study Area

Core Area

Miles 1 0 1

Km. 1 0 1

Sec. 33-78-14-W4 adjacent to the northeast tip of Crow Lake since 1978. Access to this lease is given by Licences of Occupation 820314 and 770860, which extend along the old forestry winter road in the north end of the study area, and along a small side trail that runs off the winter road to the recreation lease (Figure 5). The old forestry winter road was reserved in 1965.

3.2.2 Land Use and Disturbances

Present land uses in the study area are generally dispersed rather than intensive in nature, and the overall impact on the area has been low. At present, trapping, hunting and recreational land use are activities occurring within the study area. Three trappers have Registered Trapping Areas which fall within the study area. One maintains a cabin on the west shore of a small lake near the highway south of Crow Lake (given the unofficial name "Little Crow Lake" throughout the rest of the report) (Figure 6). There is also an old abandoned trappers cabin in Sec. 3-79-14-W4. Land use disturbance associated with trapping has been light. Access to trap lines is along existing seismic lines and trails, usually by snowmobile.

Due to its proximity to Highway 63, and to the presence of several well defined, relatively deep lakes, the Crow Lake area has moderately high capability for outdoor recreation, especially in the upland lake area in the north and west (Canada Land Inventory 1971a). Crow Lake has capability for boating, fishing, some beach activities and camping. A smaller unnamed lake south of it also has recreational potential (Figure 7). The whole study area has potential for hiking, nature interpretation and wildlife observation, especially in the upland sites. Some parts of the study area (classed as 5 and 6 in Figure 7) have moderately low recreational potential due to extensive wetlands and a lack of well defined waterbodies.

Present recreational use in the study area is centered around Crow Lake, probably because Highway 63 to Fort McMurray passes within one kilometre of its west shore. In 1980, the Alberta Forest Service (AFS) constructed a primitive walk-in campground one kilometre from the highway; it has 14 units with picnic tables and fire pits (Figure 6). Two small docks were constructed to allow boating access to Crow Lake, and a fish cleaning table was air-lifted in during the summer of 1983. Since 1979, signs have warned recreationalists that no motorized boating is allowed on Crow Lake. This regulation was put into place to reduce lakeshore erosion and to lessen disturbance of resident avifauna (Larry St. Antione 1983 pers. comm.). In conjunction with the campsite development, a parking lot with day use facilities (two picnic tables, firepits and outhouses) was constructed adjacent to the highway.

An old cabin which is located on the northeast tip of Crow Lake was taken over by WAYS and has been used intermittently by them since 1979. WAYS have also begun construction of a larger cabin, several hundred metres back from the lake.

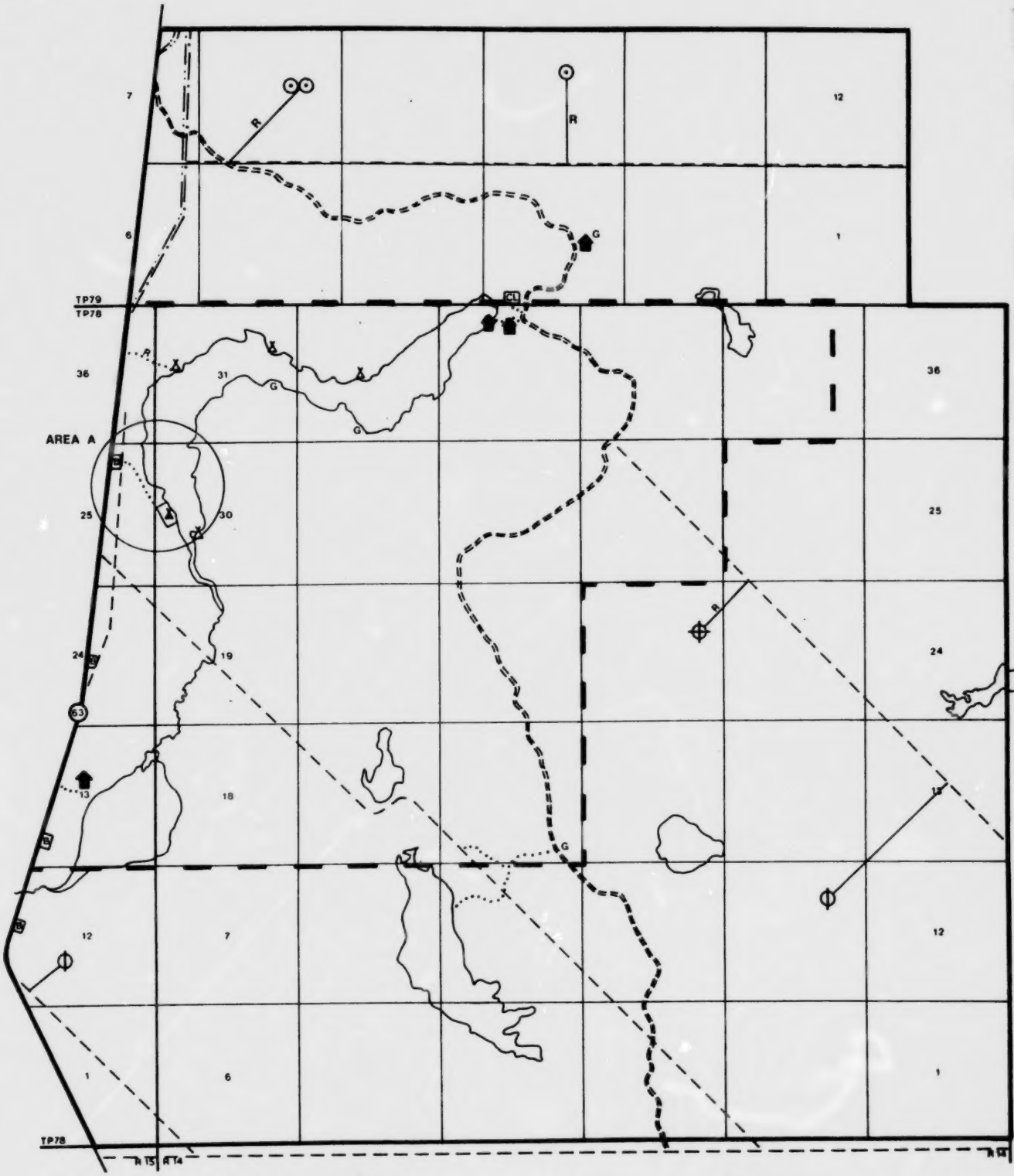


FIGURE 6 **CROW LAKE STUDY AREA**

DISTURBANCES and SELECTED LAND USE

Figure 6

DISTURBANCES AND SELECTED LAND USE

LEGEND

= = = = =	Forestry Winter Road
- - - - -	Seismic Line
.....	Trail
———	Wellsite Access
R	Reclaimed
⊙	Observation Well
⊕	Gas Well - Abandoned
⊕	Gas Well - Drilling Suspended
B	Borrow Pit
P	Parking and Picnic Facilities
CL	Clearing
D	Dock

▲	A.F.S. Campground
△	Camping Site
⬟	Cabin
G	Garage

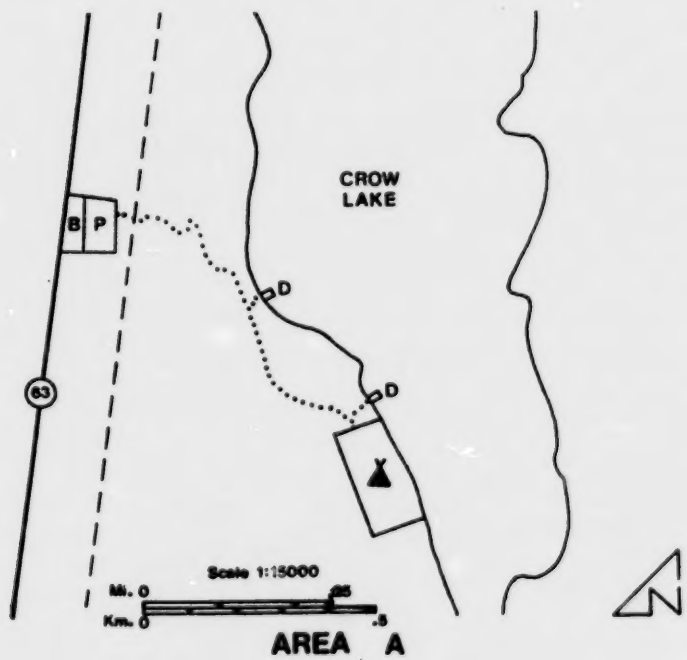
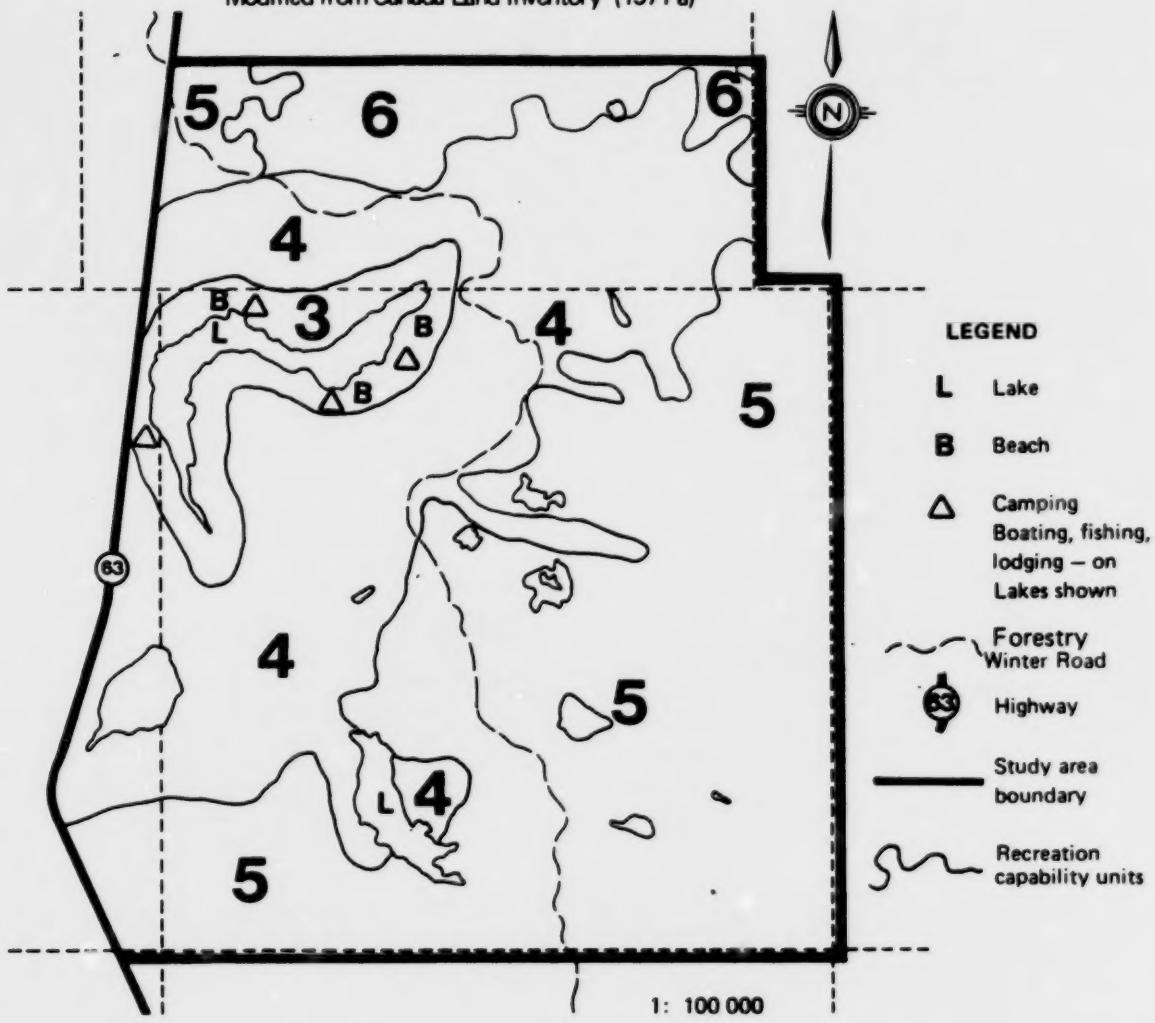


Figure 7 LAND CAPABILITY FOR RECREATION

Modified from Canada Land Inventory (1971 a)



CLASS	CAPABILITY	TYPE	POTENTIAL ACTIVITIES
3	Moderately High	Intensive or Moderately intensive	Boating, fishing, swimming, camping, lodging,
4	Moderate	Dispersed	Hiking, nature study, wildlife viewing, fishing, boating, lodging.
5	Moderately Low	Dispersed	Wildlife viewing, hiking, nature study, fishing, lodging.
6	Low	Dispersed	Wildlife viewing.

The most intensive land use in the study area in the past several years has been associated with gas exploration, although disturbances have been confined to small areas. In the late 1970s, several seismic lines were cut through the area (Figure 6). In 1981 a number of exploratory gas wells were drilled within the study area.

Observations During Summer 1983. Although the Crow Lake area receives fairly constant recreational use, intensity is light and the resulting impacts are minimal. Several inspections of the AFS campground indicated light use; four of the fire pits had never been used, and during the course of field work no campers were seen there. The biggest deterrent to potential campers appears to be the walk-in nature of the campground. Most visitors restrict their visit to the day use facilities at the highway, although no more than five vehicles were noted in the parking lot at any one time. Moderate use is made of the trails leading to the docks and campground and some litter is present. On any given day one or two boats were on the lake or several people would be fishing from the dock, although on many occasions, no recreationalists were seen. Throughout the summer, water recreation was not observed on any other lakes within the study area.

If motorized access was allowed right to Crow Lake, recreation use would probably increase dramatically. In the past there was an old four-wheel drive trail leading to the lake north of the present campground. This caused erosion and litter problems and was reclaimed in 1980 by AFS and Alberta Environment. Inspection during field work indicated that the trail is revegetating well and erosion has been arrested.

Boaters have been using various sites around Crow Lake as picnic and camping sites resulting in some garbage problems (Figure 6); this has also created a fire hazard. Several small fire scars less than one hectare in area are in evidence along the shores of Crow Lake, where it is presumed campfires got out of hand.

The major seismic lines and the forestry winter road receive light use by off-highway vehicle (OHV) recreationalists and hunters. Generally the impact on plant recolonization of these surfaces is light to moderate. Most surfaces are now vegetated by herbs and to a lesser extent, low shrubs, although bare mineral soil persists on the more unstable sandy deposits. Although there are bridges over the major creeks along the old forestry winter road, the presence of wetland and flooded spots along the route generally restricts vehicle use to winter months. Most of the access lines to the exploratory wellsites have been rehabilitated; logs and debris have been piled across the rights-of-way allowing revegetation.

The old AFS cabin on the WAYS lease has been used indiscriminately by various people. A litter problem was reported by Natural Areas Program staff in 1980, and was still a problem when the cabin was visited in 1983. Black bears regularly break into the cabin, spreading garbage and causing havoc. The WAYS group uses the old cabin

on their lease only occasionally. Although mostly finished, no construction on the new cabin has occurred for several years (Robert McIver 1983 pers. comm.).

Although there are a few areas of localized disturbance, most of the area within the study site is relatively undisturbed. As long as motorized vehicles are not allowed to have access to Crow Lake itself, recreational impacts should remain light.

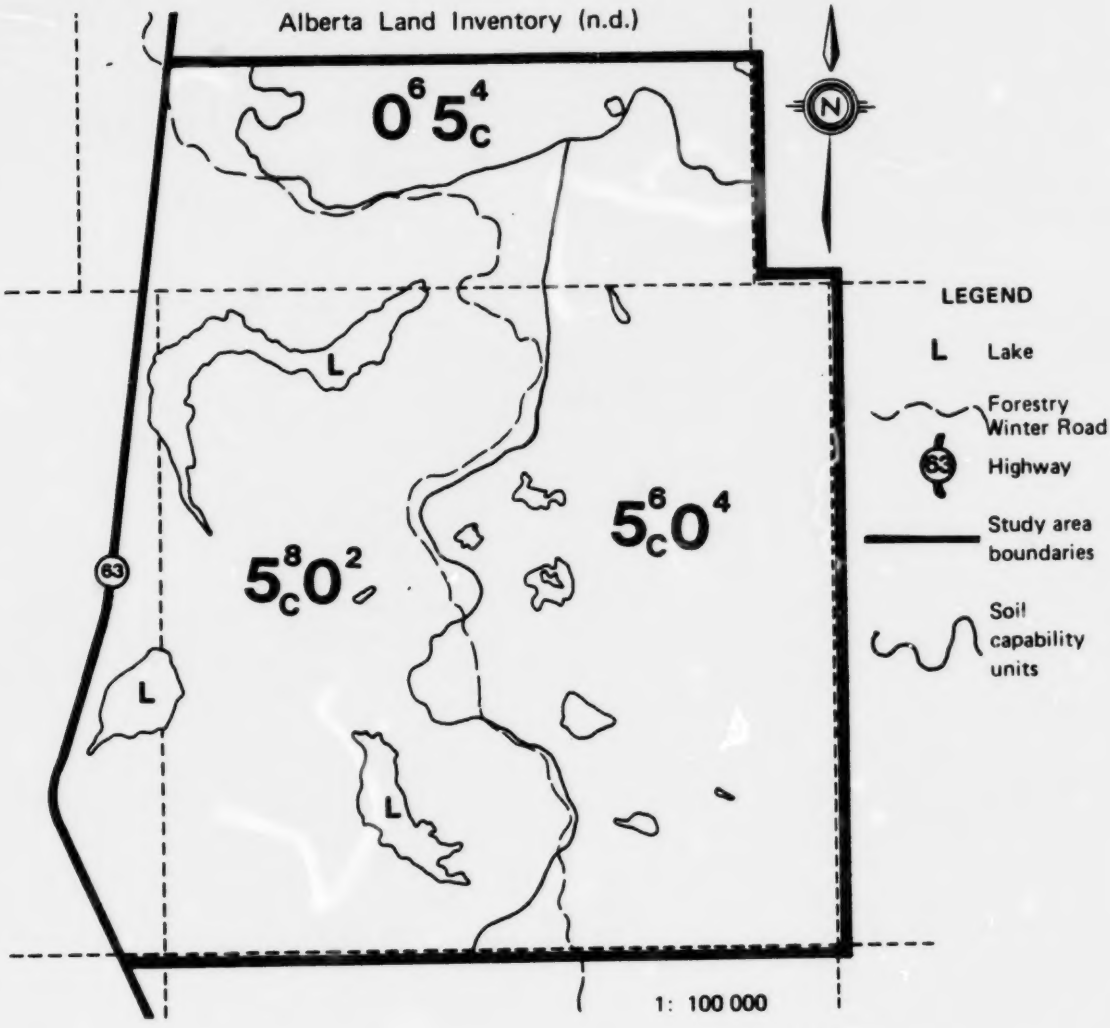
3.3 Potential Land Uses

While the Crow Lake area has the potential to support other land uses not presently developed in the area, there are some limitations. Land has been cleared for general agriculture adjacent to Highway 63 as far north as Wandering River, 65 km south of Crow Lake. However, within the study area, the potential for forage crop cultivation is severely limited by a number of factors including: rough topography, sandy infertile soil, short growing season and extensive organic deposits (Figure 8) (Alberta Land Inventory n.d.). There may be some potential for native grazing, though it is not known at what intensity this could be maintained; at present there are no grazing leases in the area.

As the study area is extensively treed with commercial forest species (white spruce, black spruce, jack pine, balsam fir) there is potential for forestry. Small logging companies do operate in the region, usually selectively cutting the more mature white spruce-balsam fir stands (Peter Achuff 1983 pers. comm.). There is no evidence that logging has occurred within the study area boundaries. Figure 9 indicates the land capability for commercial forestry (modified from the Canada Land Inventory [1971b]).

Most of the productive forested land is adjacent to and south of Crow Lake, with only moderate limitations; white spruce and to a lesser extent, balsam fir are the commercial species (trembling aspen is present in substantial quantities but is not considered a commercial species). Much of the adjoining upland areas have moderately severe limitations for forestry due to sandy soil and low fertility. Most of the eastern and northern parts of the study area are classed as having severe limitations which greatly reduce or preclude the growth of commercial forests, due to extensive wetlands and associated cold soil temperatures.

Figure 8 SOIL CAPABILITY FOR AGRICULTURE

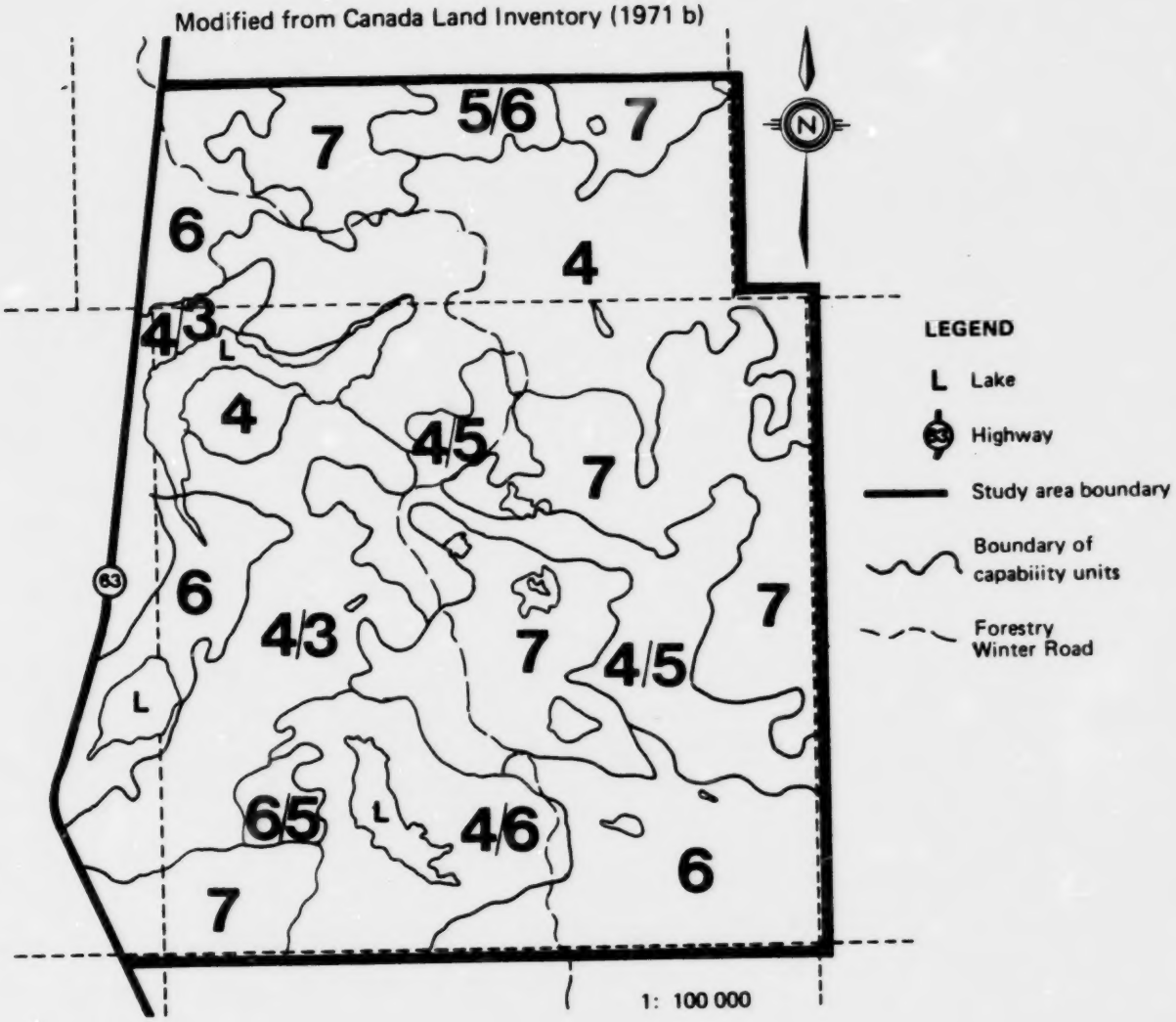


CLASS	DESCRIPTION
5_C	Soils have very severe limitations (adverse climate-low temperature) that restrict capability to produce perennial forage crops. (Improvement practices are feasible)
O	Organic Soils

Upper case letters indicate the proportion of each class type found in a particular unit.

Figure 9 LAND CAPABILITY FOR FORESTRY

Modified from Canada Land Inventory (1971 b)



CLASS	CAPABILITY	LIMITATIONS	COMMERCIAL SPECIES	PRODUCTIVITY FT^3/ACRE/YR
3	Moderate Limitations	No major ones	White Spruce	71 – 90
4	Moderately Severe Limitations	Soil moisture deficiency Low fertility	White Spruce,Jack Pine	51 – 70
5	Severe Limitations	Soil moisture deficiency Soil moisture excess Low fertility	White Spruce,Jack Pine	31 – 50
6	Severe limitations	Soil moisture excess Low temperature	Black Spruce	11 – 30
7	Severe limitations which preclude the growth of commercial forests	Soil moisture excess Low temperatures	None	10 or less

Combinations of classes are used when both classes occur over at least 40% of the unit, the dominant class is put first.

3.4 Climate

Because of its northern latitude and remoteness from any large water bodies, the Crow Lake area is characterized by a continental climate, with long, cold dry winters and short cool summers; the area is within Koppen's DC climatic zone (Ozoray and Lytviak 1980). Due to a lack of weather stations in the immediate vicinity, year round climatic data has to be extrapolated from stations at Fort McMurray (100 km north-northeast) and Lac La Biche (106 km south). Summer precipitation and temperature data is recorded at two Alberta Forest Service fire lookouts in the vicinity of Crow Lake (May Tower 28 km southwest and Christina Tower 19 km southeast).

The Crow Lake area receives relatively high summer precipitation, due to its location on the Stony Mountain Upland and position astride the mid-Alberta summer storm track. Strong and Leggat (1981) classify it within the Wet Boreal Mixedwood Subregion. Summer precipitation ranges between 380 mm and 440 mm, which is more than 70 per cent of the total yearly precipitation. Mean annual precipitation is 61 cm (Ozoray and Lytviak 1980).

As expected from a continental climate, the yearly temperature range can be quite high. Summers are relatively short and cool, due in part to the influence of precipitation, although the occasional warm spell can lift temperatures above 30°C (Longley and Janz 1978). This area receives greater moisture and cooler temperatures than other regions of the Boreal Mixedwood Section and forests here tend to show a more rapid succession to white spruce (Strong and Leggat 1981).

The boreal climatic zone is characterized by extremely low winter temperatures. This region is dominated by dry, and very cold, calm Arctic air masses in winter. These spells are broken by periods of warmer, windier and moister weather (Fairbarns 1979a), however, these chinooks are not common. Light snowfalls are frequent, and because there is a low melting rate, the snowpack can accumulate until March; snow cover lasts for approximately 150 days.

The average frost-free period is 90 days, with the last spring frosts in late May - early June and autumn frosts starting in early September (Atmospheric Environment Service 1982). Winds are generally light and there is no prevailing wind direction. Wind patterns for the Crow Lake area cannot be extrapolated from existing regional data.

Long-term climatic data (1951-1980) is presented in Appendix 7 for weather stations closest to Crow Lake.

3.5 Bedrock and Surficial Geology

The Crow Lake study area lies within the Eastern Alberta Plains physiographic unit; it is underlain by sedimentary rocks of Devonian and Cretaceous ages. The Cretaceous strata dip uniformly southwest toward the Rocky Mountains at the gentle rate of one/metre/kilometre; strata of Devonian age have a slightly steeper dip (Carrigy 1973). During the period of sedimentation since Precambrian time, this region was inundated by an inland sea and then exposed several times. Consequently, sedimentary strata of different origins (e.g., marine, deltaic, evaporitic) were formed. In this region the sedimentary column is approximately 1 200 m thick, and it abounds, on an erosional unconformity, the basement Precambrian rock (Williams 1981).

The uppermost bedrock stratum (Upper Cretaceous LaBiche Formation) is of marine origin and consists of dark grey shale, silty shale, ironstone partings and concretions. Although within the study area it is approximately 75 m thick (Hackbarth and Nastasa 1979), it does not outcrop at the surface. Figure 10 and accompanying notes describe the stratigraphic succession and dominant lithology of the post-Precambrian geological units.

There are several economically important geological strata in the region. Sandstone zones in the Lower Cretaceous (Grand Rapids, Clearwater and McMurray Formations) have been tested and shown to be gas producing (Williams 1981). There may be some potential for hydrocarbon extraction from zones in the Devonian section, but the most promising strata are probably eroded under the Crow Lake area (Williams 1981).

The study area lies on the southern margin of the oil-impregnated strata of the Athabasca Oil Sands deposit. In this region, the oil-bearing sand is in the Lower Cretaceous McMurray Formation. This stratum is exposed at the surface north of Fort McMurray and along the major river valleys to the north of the study area, though generally it is covered by a layer of glacial drift. Because of its gentle dip to the southwest, in the region of Crow Lake the oil-bearing sand lies 1 050 m under the surface and has thinned out to a stratum 40 m thick (Carrigy 1973).

Crow Lake is located in the Stony Mountain Upland, an upland unit resulting from a thick layer of glacial drift overlying a minor bedrock high in the underlying La Biche Formation (Hackbarth and Nastasa 1979). The glacial drift covering the Stony Mountain Upland ranges in thickness from 100 m in the south to more than 200 m in the north (Ozoray and Lytviak 1980). At Crow Lake the thickness of the unconsolidated sediments probably vary from 150 m in the upland areas (690 m ASL) to less than 100 m in the major stream valley bottoms (610 m ASL). No bedrock exposures were observed within the study area, and it is doubtful that any exist, as the stream valleys are not incised deep enough into the glacial overburden.

DESCRIPTION OF STRATIGRAPHIC COLUMN
CROW LAKE STUDY AREA

Quaternary

Qsg - Sands and Gravels.

Cretaceous

Upper

Klb - La Biche Formation: dark grey shale and silty shale; ironstone partings and concretions; marine.

Lower

Kj - Joli Fou Formation: dark grey fossiliferous shale, silty beds in upper part; marine.

Kg - Grand Rapids Formation: fine-grained quartzose and feldspathic sandstone, laminated siltstone and silty shale; thin coal beds; shoreline complex; gas producing zone.

Kc - Clearwater Formation: dark grey, fossiliferous, silty shale; laminated siltstone and fine-grained cherty sandstone; marine; gas producing zone.

Km - McMurray Formation: thick-bedded quartzose sandstone and siltstone; oil-impregnated; grey silty shale interbeds; non-marine to deltaic; zone of gas production.

Devonian

Upper

Dbl - Woodbend Group and Beaverhill Lake Formations: grey and greenish grey shale and shaly limestone; dolomite in upper sections, fragmental limestone in lower sections; marine.

Middle

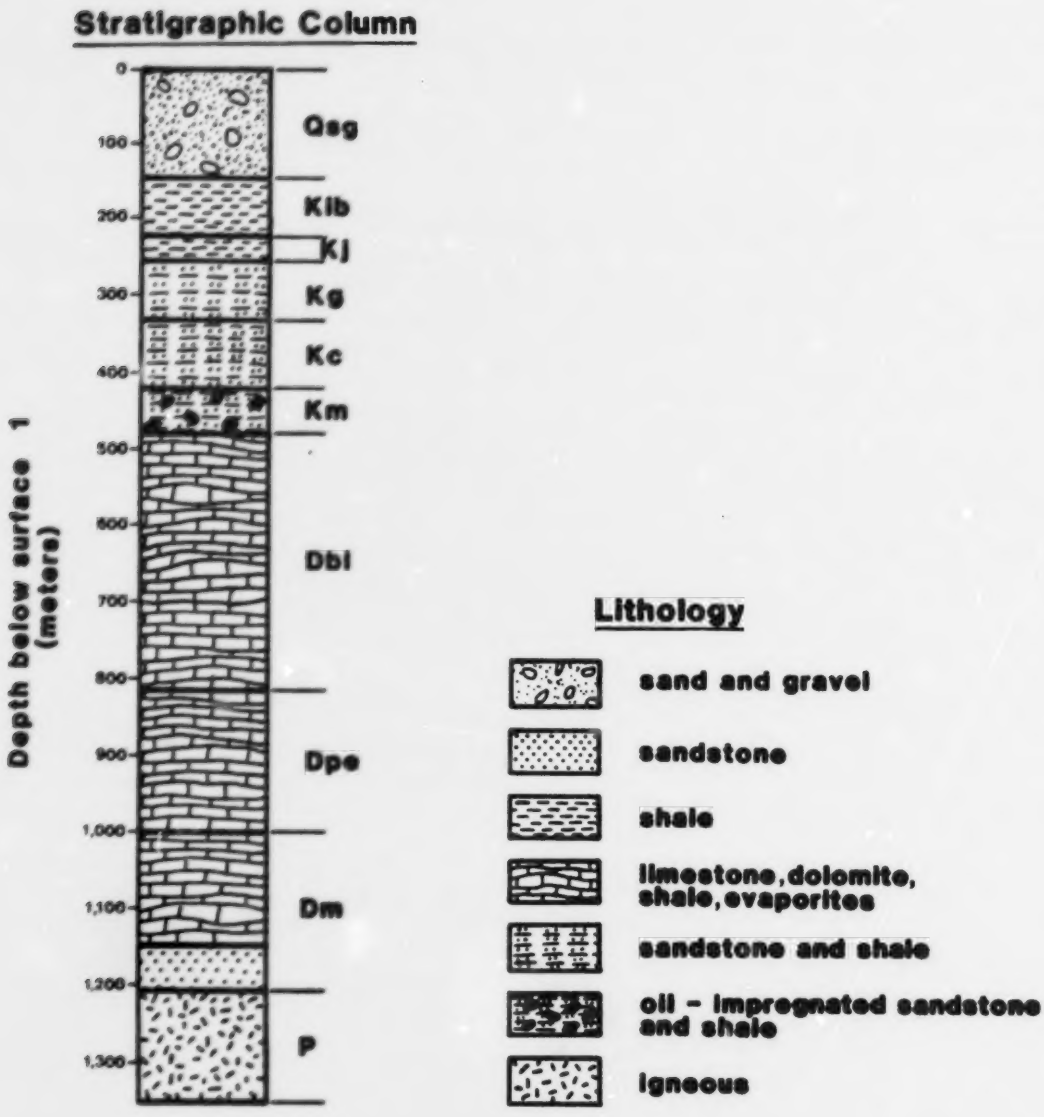
Dpe - Fort Vermilion, Watt Mountain and Prairie Evaporite Formations: dolomite and limestone in upper sections; white and green gypsum, anhydrite, minor dolomite, green shale and salt in lower sections; evaporitic.

Dm - Methy, McLean River and La Loche Formations: gypsiferous and calcareous dolomite, in part reefal; shale, sandy shale in middle sections; sandstone in lower sections.

Precambrian

P - Metasedimentary rocks and granite.

Figure 10. Geology of Crow Lake Study Area



Source : Subsurface geological information compiled from Green 1972, Norris 1973, Heckbarth and Nastasa 1979 and Ozoray and Lytviak 1980.

1 mean elevation of study area : 640 metres

The glacial history is not well known for this part of the province (Wayne Tedder 1983 pers. comm.). This region was glaciated a number of times during the Pleistocene Epoch, of which several advances may have contributed to the present layer of glacial drift. The aging of the stratigraphic till units and correlations with tills found elsewhere in Western Canada are not possible because their chronology is not known (McPherson 1977).

Unlike some of the higher uplands in northern Alberta, this area was overrun by ice during the most recent late Wisconsin glacial advance (Ozoray and Lytviak 1980). The surficial geology in the study area is a reflection of this most recent glaciation and was formed by the youngest episode of glacial and postglacial deposition and erosion acting on the pre-existing glacial drift deposits. A number of glacial processes operated in this area, resulting in a complex mosaic of glacial landforms; these include depositional and erosional features (e.g., moraines kames and meltwater channels).

Like much of the surrounding region, most of the surficial glacial deposits in the study area are composed of sandy outwash, with some areas of gravel outwash and unconsolidated till (Gravenor and Bayrock 1961). Clayey and sandy till is assumed to be widespread over the uplands of the study area as level to undulating ground moraine and also as hummocky and subdued ablation moraine (Wayne Tedder 1983 pers. comm.). The release of glacial meltwaters during stagnation of the Keewatin ice sheet eroded channels in the till and left a ubiquitous veneer of sandy outwash over the morainal deposits. Within the Crow Lake basin and the upland area south of Crow Lake, the meltwaters deposited sandy outwash adjacent to ice masses and within crevasses; these deposits were left as ridges and hummocks when the ice melted. The largest kame ridge is approximately four kilometres in length and 10 m in height.

Well-developed glacial flutings occur just outside the study area, several kilometres to the northwest. They trend northeast to southwest paralleling the direction of ice movement. They are probably composed of glacial till and formed when a glacial advance overroad existing glacial drift (Gravenor and Meneley 1958). These flutings are plainly visible on 1:50 000 air photos.

3.6 Physiography and Drainage

The Crow Lake study area lies wholly within the House Plain physiographic sub-region just inside the western border of the Stony Mountain Upland (Pettapiece n.d.). The western and northern boundaries of this upland are defined by the 600 m contour interval. Regionally, the land gently slopes northwest toward the Athabasca River.

Generally, the study area can be divided into two landscape units. The first is a major valley system [probably an old glacial

spillway (Wayne Tedder 1983 pers. comm.)] which includes Crow Lake; it runs from the northeast corner of the study area towards the west, and then turns south to follow along the west boundary. Most of the valley sides are composed of undulating to hummocky topography which slopes toward the valley bottom.

The second landscape unit consists of several large areas of flat to undulating, poorly-drained upland which are prominent in the south, east and extreme north sections of the study area. In these areas the land slopes gently toward the valley breaks surrounding Crow Lake.

Relief throughout the study area is low, except along the slopes bordering the valley surrounding Crow Lake where differences of up to 60 m over short distances can be found. Crow Lake lies at an elevation of 612 m ASL whereas most of the study area is between 670 and 690 m ASL. The highest elevation is in the extreme north-central part of the study area (710 m ASL) and the lowest point is where Crow Creek exits the study area in the southwest corner (610 m ASL) (Figures 16-18).

Subsequent to the glacial influence, the most recent modification to the landscape has been peat formation in the poorly-drained level and depressional areas. Peat deposits are a common feature of this area and are quite extensive on the upland portions of the study area.

The Crow Lake study area lies completely within the House River watershed (Figure 11). The House River originates 25 km north-northeast of Crow Lake and flows south, passing east of the study area. Its channel then curves west and northwest, passing within three kilometres of the southwest corner of the study area. From there it flows north-northwest, eventually emptying into the Athabasca River (Figure 11).

Crow Creek (a tributary of the House River) forms the major drainage system in the study area, with its watershed occupying 75 per cent of the land within the study area boundaries (Figure 12). Crow Creek, Crow Lake and "Little Crow Lake" occupy the broad bottom of the old glacial spillway. Crow Creek flows southeast toward its confluence with the House River, three kilometres west of Highway 63.

There are 19 permanent water bodies (excluding the numerous beaver ponds) which lie wholly or partly within the boundaries of the study area. Variable in character, they range in size from Crow Lake (256 ha) to the smallest at just over one hectare. They are of two general types: 1) those that occur in the more rolling topography in the west and north and 2) those that have formed in shallow depressions in the flatter upland areas. The former type, which includes the three largest water bodies, have well-defined margins, are deep and are connected by streams to the Crow Creek drainage system. The latter ones are relatively shallow and surrounded by wide expanses of wetland vegetation. They occur within the poorly-drained peatlands in the eastern part of the study area and in many cases are not drained by a

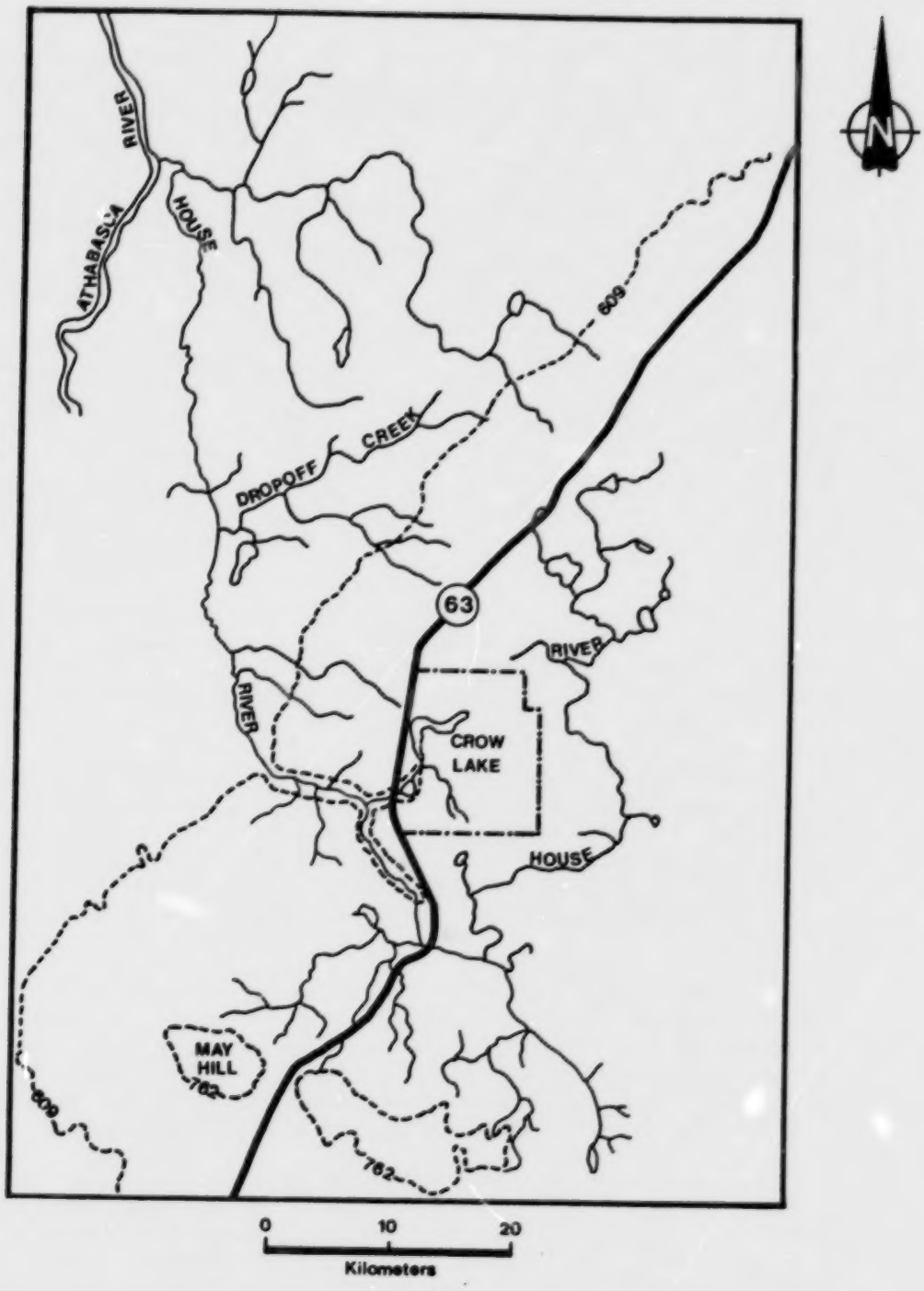


Figure 11. House River Watershed

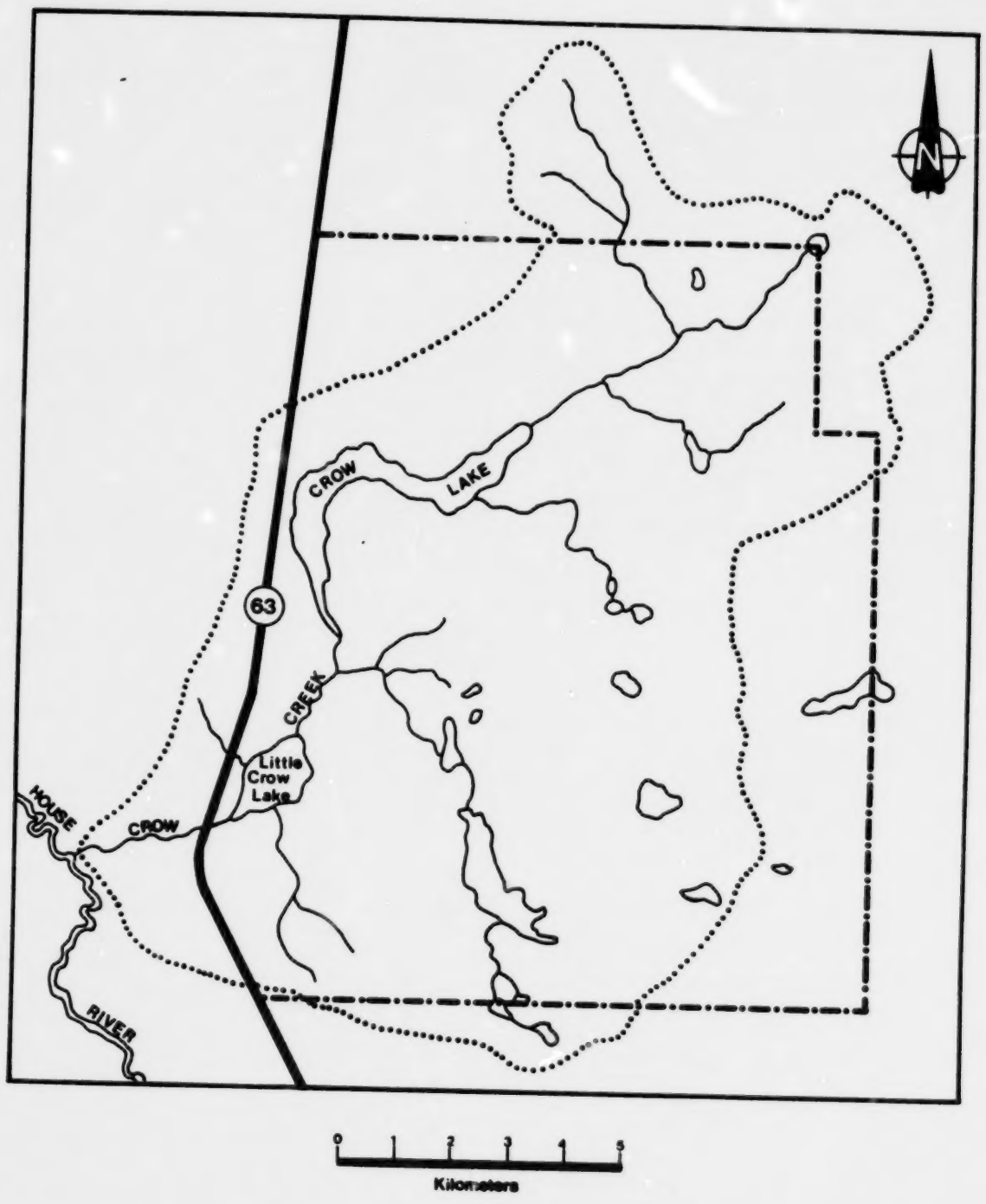


Figure 12. Drainage of Crow Lake Area

channelized stream system. Although these latter water bodies are small, shallow and clogged with vegetation in summer, they do not appear to dry up in summer.

There are numerous smaller ponds and water-filled depressions in the study area, especially in the peatland areas. Their water levels fluctuate with the seasonal ground water level and during some summers may dry up completely.

The presence of large peatland areas within the study site is due to a regionally high water table, in which the groundwater table is at the surface, or very close to it, although in some cases the water table may be perched. Because of the extended periods of soil frost in this relatively northern location, groundwater flow systems are hampered, resulting in wet conditions. In this situation, most of the groundwater moves in the upper few metres of the substrate (which is mostly organic soil), parallel to the surface. This contrasts with groundwater flow in drier areas or regions of shorter frost periods, in which groundwater flow is more penetrating (Ozoray and Lytviak 1980).

3.7 Soils

Much of this discussion is based on information prepared by Wayne Tedder (Public Lands Division, Alberta Energy and Natural Resources) following a soils reconnaissance trip to the Crow Lake site in July 1983. Previous soil surveys in the study have been of an exploratory nature only, with classification to the subgroup level (Wynnyk et al. 1956).

The exploratory soil survey noted the highly variable nature of the soil profiles in the area. The parent materials of the mineral soils consist of sandy glaciofluvial deposits (outwash, kame) interspersed with smaller areas of more finely-textured morainal deposits. Textural and horizon variations between profiles are common due to the variable thickness of the sandy, glaciofluvial veneer which can range from several centimetres to many metres in depth (Wynnyk et al. 1956). Many of the sandy deposits are fairly acidic, which has had an influence on the regional soil development. Notwithstanding the complex mosaic of soil types, some broad generalizations concerning soil distribution are presented below. Soil profile data from the study area is presented in Appendices 8A, B, C and D. Figure 13 indicates the locations of the soil pits.

On sandy substrates approaching one metre or greater in thickness, Brunisolic soils have developed. Ridged, hummocky, subdued and undulating topography is associated with these deposits. The pH of the Bm horizon ranges from 5.3 to 5.8 but is generally less than 5.5. The generalized soil profile is moderately well- to rapidly-drained, and consists of 6-10 cm of L-F-H, 8-12 cm of a sandy-textured Ae,

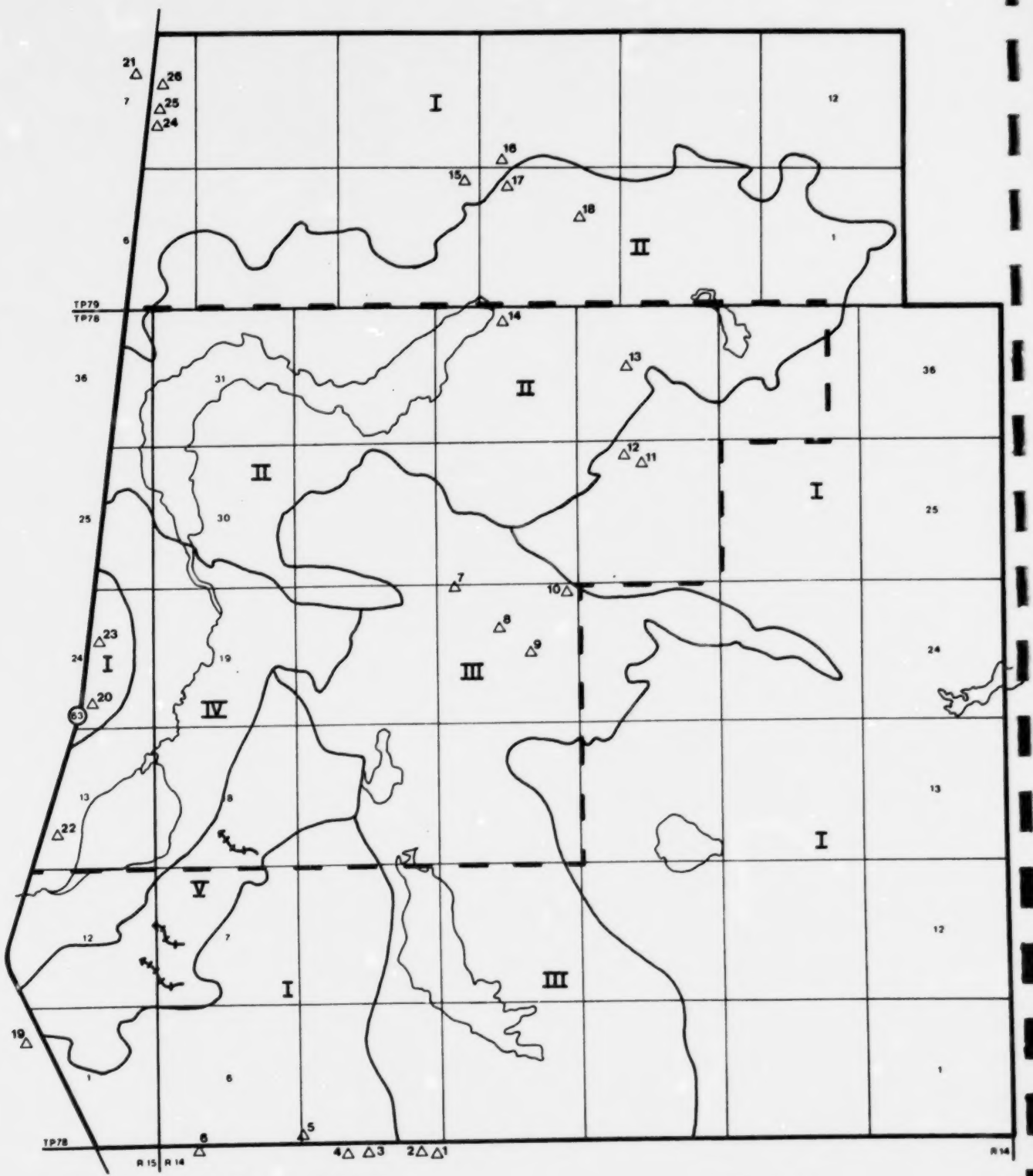


FIGURE 13

CROW LAKE STUDY AREA

TERRAIN SYSTEMS CLASSIFICATION AND SOIL PROFILE LOCATIONS

Figure 13

TERRAIN SYSTEMS CLASSIFICATION AND SOIL PROFILE LOCATIONS

LEGEND

Terrain Systems

I Organic - Morainal Upland Complex

II Valley Glaciofluvial

III Upland Glaciofluvial - Organic Complex

IV Glaciofluvial Channel

V Dissected Moraine

Small Meltwater Channels

Soil Profiles

△ Soil Pit - refer to profile descriptions in Appendix 8

12-20 cm of a sandy to loamy sand Bm and a loamy sand to sandy C horizon. The C horizon begins at a depth of 27-53 cm.

Variations in this profile include sites with a clayey till subsoil and weak gleying in the C horizon; this can even occur on the upper slope positions. A thin Ahe horizon occurs when the profile has developed under a mesic upland aspen or balsam poplar stand. Overall stone content is generally less than five per cent (gravels) but may occasionally approach 75 per cent (gravels and cobbles) in profiles on kame deposits.

Eluviated Dystric Brunisols are thought to be most common on the most coarse-textured sandy ridges. Vegetation on these soils usually consists of open jack pine forests although mixedwoods and even black spruce - feathermoss stands are common. Eluviated Eutric Brunisols are commonly interspersed with the Dystric soils and may occur more often on the thinner sandy veneers. Appendix 8A gives the soil description of the Brunisolic profiles.

In the less rapidly-drained areas where till deposits are overlain with a thin sandy veneer of glaciofluvial material, Brunisolic Grey Luvisols appear dominant. The veneer of outwash is usually sand, loamy sand or sandy loam and ranges from 13-28 cm in thickness. Within this coarse-textured veneer, an Ae horizon of 5-12 cm and a Bm horizon of 5-18 cm has developed. In one profile the pH of the Ae was 3.8 while the Bm was 5.4. Usually a fine platy structure is present in both horizons. Overlying the Ae is a L-F-H layer of 7-11 cm. The horizon of illuvial clay accumulation (Bt) usually has a weak, fine subangular blocky structure and is 9-21 cm thick. The texture of the Bt is clay loam to sandy clay loam. A BC horizon of approximately 12 cm is often present. The C horizon is present at a depth of 38-61 cm and the texture consists of clay loam, sandy clay, sandy clay loam or clay. Stone content is mainly less than five per cent (gravels and cobbles) with fewer stones in the sandy overlay. These soils are well- to moderately well-drained and are located on level to undulating topography. They are often associated with mesic mixedwood, deciduous or mature spruce - fir forests.

Variations in the Brunisolic Gray Luvisol profile include a second Ae horizon beneath the Bm horizon and gleyed phases in imperfectly-drained locations. In some areas, an Orthic Gray Luvisol profile has developed (Soil Profile No. 22, Appendix 8B). This is the modal soil type on the finer grained till units (Achuff 1974). However, due to the small amounts of till found at the surface, this soil type is probably not too common in the study area. Information on the Luvisol profiles is contained in Appendix 8B.

In very poorly-drained level to depressional areas, peat has slowly accumulated to thicknesses of over one metre. Although both sphagnum (Sphagnum spp.) and sedge peats are present, the former type is probably more abundant (Wynnyk et al. 1956). The upper tier (0-60 cm) is predominantly poorly decomposed peat (fibric). The middle tier contains both poorly and moderately decomposed peat (fibric and mesic). The pH ranges from 4.0-4.5. Insufficient information was

gathered to classify the soils to the subgroup level but Fibrisols are likely dominant, with lesser amounts of Mesisols. Appendix 8C lists information for the organic soil profiles.

Orthic Gleysols have developed in poorly-drained depressions where the organic layer is thin. The one profile that was examined consisted of 25 cm of fibric peat overlying stonefree sandy loam glaciofluvial material (Appendix 8D). A 4-5 cm thick Ahej with a very weak platy structure overlies a 14 cm thick Bm. The Cg horizon is at a depth of 18 cm and has many medium sized, prominent mottles. Vegetation in these areas is usually open black spruce - heath.

4. TERRAIN SYSTEMS

Based on air photo interpretation and on the soils and geomorphology reconnaissance trip, a broad level classification of terrain systems has been developed for the study area by Wayne Tedder, Public Lands Division, Alberta Energy and Natural Resources. This classification has been mapped at a scale of 1:50 000 (Figure 13) and incorporates soils and geomorphological data.

4.1 System I: Organic - Morainal Upland Complex

This system is located on the level to undulating upland plain at an elevation of 680 m to 700 m (Figure 13). It is characterized by the abundance of sphagnum-dominated peatlands and smaller deposits of moraine and glaciofluvial materials. The peatlands are quite variable in size and range from treed poor fen types to open poor fens. Often they contain open water. Fibrisols and Mesisols can be expected in the thick organic deposits. Gleysols are common in the shallow peat deposits located in small depressions and around the margin of larger fens.

Moraine is widespread in this system and is usually in the form of low relief hummocks and undulating topography. On many areas, glaciofluvial deposits occur as a sandy veneer of varying thickness overlying moraine and as sporadic hummocks and ridges. These deposits are usually sandy and relatively stone-free and occasionally quite gravelly or cobbly.

The dominant mineral soils are Brunisolic Gray Luvisols, Eluviated Dystric Brunisols, Eluviated Eutric Brunisols and gleyed phases of the above soils. The Luvisolic soils are associated with morainal parent material that usually has a thin sandy veneer. The Brunisolic soils are associated with thick sandy materials and also with some sandy veneers overlying till.

4.2 System II: Valley Glaciofluvial

This terrain system occupies the broad valley occupied by Crow Lake and is at an elevation of 610 m to 685 m (Figure 13). The valley walls have been significantly modified by glacial meltwaters, especially in the eastern portion. This system is characterized by thick sandy and occasionally gravelly glaciofluvial deposits in the form of ridges and hummocks as well as by steeply-inclined slopes. Minor depressional areas contain organic deposits of variable thickness.

The dominant soils on well to rapidly-drained materials are expected to be Eluviated Dystric Brunisols and Eluviated Eutric Brunisols with a minor component of Brunisolic Gray Luvisols. Fibrisols, Mesisols and Gleysols are likely in the poorly-drained areas.

4.3 System III: Upland Glaciofluvial - Organic Complex

This system is located south of Crow Lake on the upland plain at an elevation of 670 m to 695 m (Figure 13). It has been subjected to considerable glaciofluvial processes as is reflected in the surface expression. Clusters of roughly parallel, low relief ridges were formed when meltwaters deposited material into the stagnating ice crevasses. In the northern portion of the area, other ice-contact forms are present, with one elongated kame stretching for approximately three kilometres.

These deposits generally consist of thick sand with a low stone content but also include areas of sandy veneers overlying clayey till. Eluviated Dystric Brunisols and Eluviated Eutric Brunisols as well as gleyed phases are assumed to be dominant. Minor occurrences of Luvisolic soils can be expected in association with till deposits.

Depressions between ridges are generally small in area but overall form a significant part of this system. Fibrisols, Mesisols and Gleysols can be expected in the variable depths of peat present in these poorly-drained depressions.

4.4 System IV: Glaciofluvial Channel

This broad valley system is an extension of the valley that contains System II but is considerably different in terms of surface expression, relief, dominant soils and parent materials (Figure 13). It is the old glacial spillway which carried meltwaters from the adjacent eastern and northern areas. There was very little deposition

of glaciofluvial materials with the exception of a sandy veneer. Numerous hummocks within the channel were formed from debris which was released from the stagnating ice. A small meandering stream (Crow Creek) serves as the outlet for Crow Lake and flows through this system into "Little Crow Lake".

The channel is located at an elevation of 610 m to 650 m. The lower elevations are dominated by poorly-drained mineral soils and thin organic deposits in which Gleysols, Fibrisols and Mesisols are dominant. The higher elevation mineral deposits are better-drained and likely have Brunisolic and Luvisolic soil profiles depending on the texture of the material. Only one soil profile was described in this unit and it consisted of a Brunisolic Gray Luvisol that developed on clay loam till with a thin sandy overlay.

4.5 System V: Dissected Moraine

This small area of well-drained upland is located adjacent to the eastern border of System IV (Figure 13). It forms the eastern wall of the old glacial spillway but is primarily on the upland plain. The elevation ranges from 640 m to 680 m. The system was dissected by small meltwater channels which originally flowed in a westerly direction across this undulating and subdued topography. Veneers of glaciofluvial sands can be expected to overlie the till over most of this area. Moderately well-drained Brunisolic Gray Luvisols are likely dominant, with minor areas of well-drained Brunisolic soils.

5. FAUNA

The diversity of boreal forest habitat types in the Crow Lake area is reflected in the variety of faunal species which are found there.

5.1 Avifauna

The Crow Lake study area is generally rated by the Canada Land Inventory (1979) as having severe limitations to the production of waterfowl. The major limitations cited are a lack of open wetlands due to flat topography and an insufficient fertility for proper plant growth. This classification is certainly appropriate for the extensive peatlands area.

Crow Lake and the second largest lake in the study area [in 4, 8, 9-78-14-W4 (Figure 14)] are also rated as having severe limitations to waterfowl production due to reduced suitable shoreline habitat because of deep water. One of the waterbodies in the eastern portion of the study area is slightly better with only moderately severe limitations to the production of waterfowl.

By far the best site for waterfowl production within the study area is "Little Crow Lake" (Figure 14); field observations confirm this. It has the best developed shore marsh community in the study area and is shown on the Canada Land Inventory maps as having only moderate limitations to waterfowl production. During vegetation analysis in the area, waterfowl observed included mallard (Anas platyrhynchos), common goldeneye (Bucephala clangula) and lesser scaup (Aythya affinis) (Figure 14). But, because this type of habitat is not common in the study area, it as a whole is probably not important as a waterfowl production, moulting and staging area, at least in a regional context.

Several important raptorial species were noted in the study area. A single adult bald eagle was seen several times in July, both times along a lakeshore (Figure 14). A bald eagle nest was located in a large aspen on the shore of Crow Lake, but appears to have been abandoned for several years, though use was noted as recently as 1979 (Lee et al. 1979). Sightings of an individual osprey were made, also in the vicinity of the larger waterbodies. Although these two species may not be presently nesting within the study area, their presence is

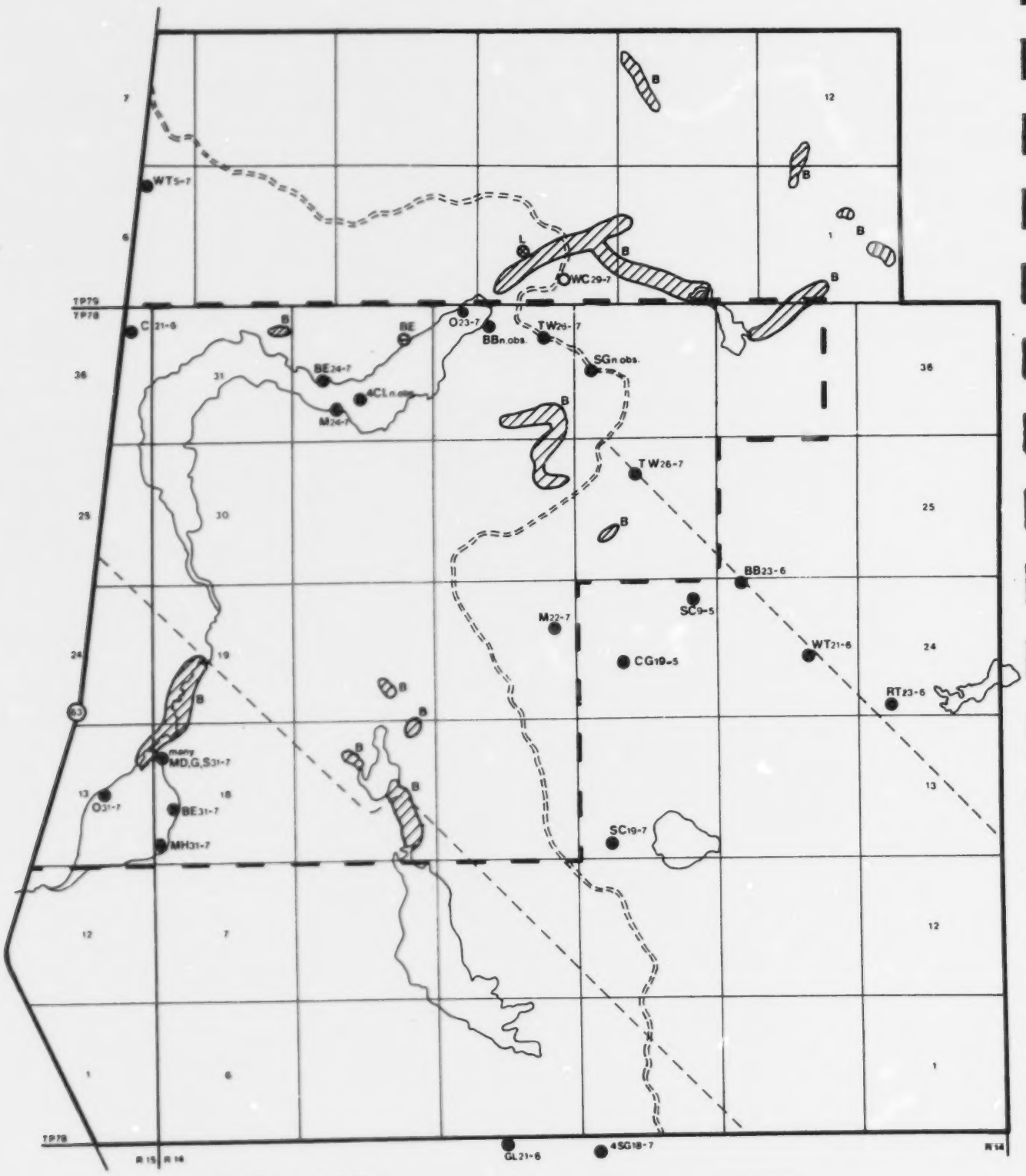


FIGURE 14 **CROW LAKE STUDY AREA**
SELECTED WILDLIFE OBSERVATIONS (MAY - JULY 1983)

Figure 14

SELECTED WILDLIFE OBSERVATIONS

LEGEND

●	Sightings
O	Tracks
⊗	Other Observations
N.OBS.	Numerous Observations
WT	White-tailed Deer
WC	Woodland Caribou
M	Moose
C	Coyote
TW	Timber Wolf
BB	Black Bear
L	Lynx Skull
B	Beaver Activity
⊖	Bald Eagle Nest
BE	Bald Eagle
RT	Red-tailed Hawk
MH	Marsh Hawk
O	Osprey
SC	Sandhill Crane
CL	Common Loon
CG	Canada Goose
G	Common Goldeneye
MD	Mallard
S	Lesser Scaup
GL	Greater Yellowlegs
SG	Spruce Grouse
— — —	Seismic Line
= = = = =	Forestry Winter Road

significant. Several studies (e.g., Beaver 1977; Renewable Resources Consulting Services Ltd. (RRCS) 1975b) have indicated that both osprey and bald eagle which are classified as rare, are found in limited numbers in northeastern Alberta.

Several other bird species which are considered sensitive by Beaver (1977) were observed within the study area (in this discussion, "sensitive" means easily disturbed by human activities). These include colonial species such as Bonaparte's gull (Larus philadelphia) and California gull (L. californicus), of which several individuals were seen on Crow Lake. Other sensitive species include the common loon (Gavia immer) and sandhill crane (Grus canadensis). At least three pair of loons were seen on Crow Lake during the summer, and they were identified by sound on some of the smaller water bodies within the study area. At least one pair of nesting sandhill cranes was observed in the central part of the core area within a fen - upland jack pine complex.

General observations made of bird species by the author during the 1983 summer vegetation survey are assembled in Table 1, with selected observations shown in Figure 14. This is supplementary information to the report of Rintoul and Myers (1983).

5.2 Ungulates

Woodland caribou (Rangifer tarandus), moose (Alces alces), mule deer (Odocoileus hemionus) and white-tailed deer (O. virginianus) are the ungulate species which occur in the Crow Lake region (RRCS 1974). The Canada Land Inventory (1975) rates lands within the study area as having a fairly good capability to support ungulates, with only moderate limitations due to excessive soil moisture, flat topography and lack of fertility for optimum plant growth. Lands within this class are thought to be used as summer range by ungulates, while in winter the moose and deer would move down into the sheltered areas of the major river valleys. During the course of the field season, signs of caribou, white-tailed deer and moose were noted.

Moose are by far the most common ungulate within the study area during the summer. There were two sightings of a single adult; one in an alder (Alnus spp.) thicket on Crow Lake, the second in a shrubby fen south of the lake (Figure 14). Numerous signs of moose were observed throughout the study area (tracks, fecal pellets).

Evidence of moose activity was noted in a variety of upland aspen and mixedwood habitats. However, activity was concentrated in the shrubby wetland habitats including shrubby fens, willow wetlands, open black spruce peatlands and alder-dominated streamsides. Willow, alder and saskatoon-berry (Amelanchier alnifolia) were noted to be the preferred browse species. Food and habitat preferences are similar to

Table 1

OBSERVATIONS OF AVIFAUNA DURING SUMMER 1983

Species	Habitat	Comments
Common loon	open water	At least two and possibly three pairs resided on Crow Lake throughout the summer. Loons were heard on three of the smaller water bodies in the east and south parts of the study area during the summer.
Canada goose	open water	Several individuals sighted on May 19 on large pond southeast of Crow Lake.
Mallard, Common goldeneye, Lesser scaup	deep marsh	Many individuals seen on July 31 on lake southwest of Crow Lake (Little Crow Lake). Thirteen females seen at northeast end of Crow Lake on July 30.
*Blue-winged teal	open water	Two adults observed in mid-July along north shore of Crow Lake.
Red-tailed hawk	forest edge	One adult seen on east edge of study area, flying along forest edge by a large fen.
*Marsh hawk	shore marsh	An adult was seen on July 31 flying low over shore of Little Crow Lake.
Osprey	lake shore	One observed at Little Crow Lake, July 31.
Spruce grouse	upland coniferous forests	This species was sighted numerous times throughout the summer, especially in May and July. Usually solitary females seen, with groups of up to four adults noted. Common along forestry winter road and seismic lines in drier coniferous woods, in all parts of the study area. Feces often noted.

*Common snipe	open forest edges near fens	Noted several times during the summer.
*Greater yellowlegs	marsh edge	One adult seen in an old tree by a marshy pond, June 21, in the southern part of study area.
Lesser yellowlegs	marshes and fens	Several seen during the summer throughout the study area.
Hairy woodpecker	mixedwood and coniferous forests	Observed a number of times throughout the forest.
Olive sided flycatcher	spruce forest	Noted several times.
Tree swallow, Barn swallow	open forest edge	One of each species seen near Crow Creek, July 31.
Boreal chickadee, Black capped chickadee	coniferous to deciduous forests	Common. Sighted often.
Red winged blackbird	shrubland and marsh edges	Observed many times, often several adults seen together.
*Yellow warbler	willow swamp	One adult seen July 9.
Dark-eyed junco	forested habitats, especially coniferous, open spruce peatland	Very common, seen frequently throughout the summer.

NOTE: * Species not observed by Rintoul and Myers (1983)

those noted in other studies in northeastern Alberta (e.g., Gunderson and Rippen 1978, Hall et al. 1974a).

In a regional context, Crow Lake has only fair summer habitat for moose. Although aspen forests, mixedwoods and peatland covers 11.3 per cent, 16.3 per cent and 13.9 per cent of the study area respectively, the most preferred habitat types (shrubby fen, willow-dominated wetlands and early successional communities) cover less than eight per cent of the study area (Table 8).

During winter, moose will utilize deciduous forests, open peatlands and riparian habitat (Hall et al. 1974b). However, if the winter is particularly severe (deep snow and/or cold), they will move down into the major river valleys, seeking sheltered south-facing slopes with favourable browse species (aspen and balsam poplar, willow, saskatoon-berry) (Hall et al. 1974a). In the Crow Lake area, the stream valleys in the Crow Lake basin may provide some favourable habitats, however the more critical overwintering areas are along the Athabasca River (30 km west), along some of the Christina River tributaries (10 km southeast) and, to a lesser extent, the House River valley (10 km southeast) (Alberta. Fish and Wildlife Division 1981). Winter ungulate surveys in the region have found moose densities of $0.47/km^2$ in the area from the Athabasca River to Highway 63, west of Crow lake and $0.17/km^2$ to $0.31/km^2$ in the Christina Lake region, east of Crow Lake (Story et al. 1976; Gunderson and Rippen 1981, respectively).

White-tailed deer were sighted twice during the summer, once along the highway and once along a forest edge in the east part of the study area (Figure 14). They are not as common as moose and tend to use mixedwood habitat. Regionally, they are more numerous toward the south, favouring the more open habitat made available by agricultural land use (Novak 1969). Although there were no mule deer sighted during the study, they have been observed near Crow Lake in the past (Hall et al. 1974b). They tend to range in the more heavily-wooded regions. In general, deer sign (tracks and pellets) were observed in mixedwood forests. As with the other ungulates and some fur-bearing species, the deer seem to use the old forestry winter road and seismic lines as major pathways, and much of the animal signs noted during the summer were seen along those routes.

Woodland caribou are known to occur within this region, although it is near the southern limit of their range in eastern Alberta (Novak 1969). In northeastern Alberta, the caribou populations exhibit great seasonal fluctuations in numbers, distribution, group associations and behaviour. Because they are hard to observe, their numbers are probably underestimated (Alberta Oil Sands Environmental Research Program (AOSERP) 1976). Mixed groups of bulls and cows diminish in size until the cows separate to calve in early spring. Individuals remain isolated from one another until the fall, when grouping occurs again. In northeastern Alberta, average group sizes cycle from six in mid-March, dropping to just over one by July and rising again in October, according to a 1976 AOSERP study. This study also noted that caribou are found mostly in black spruce peatland

(38 per cent), mature conifer forests (16 per cent) and to a lesser extent in open jack pine / lichen-dominated stands (seven per cent).

Within the study area, the most favourable habitat for caribou is on the east side of Crow Lake. The only caribou sign during the summer was noted in that region; fresh tracks of a lone adult were seen on the forestry winter road in upland spruce - pine forests. Summer density of caribou in this region is probably fairly low, and with a range that can encompass up to 450 km^2, the study area would serve only as part of their habitat requirement.

On a regional scale, Crow Lake is not particularly noted as important winter caribou habitat, although they have been seen in the area (Novak 1969; Hall et al. 1974b). More critical winter habitat is in several areas 70 km to the east and southeast (Christina River area) and west of the Athabasca River (Alberta. Fish and Wildlife Division 1981).

5.3 Furbearers

There has not been much information published on furbearers in northeastern Alberta; most of the information on species abundance and distribution is based on Alberta Fish and Wildlife statistics on winter fur harvests by registered trappers (RRCS 1975a). Use of their fur harvest records as indicators of population densities in a specific area can be misleading because of the extreme variation in trapline effort.

Trapper effort may also shift periodically, emphasizing certain species which can be trapped most lucratively. For example, since 1960, there has been a shift from large quantity - low value species [e.g., American red squirrel (Tamiasciurus hudsonicus), snowshoe hare (Lepus americanus)] to less numerous but more valuable species such as coyote (Canis latrans), fisher (Martes pennanti), lynx (Lynx lynx), marten (Martes americana) and river otter (Lontra canadensis) (Todd and Geisbrecht 1979). As a result, the densities of the latter species will be overestimated as compared to the former. Another limiting factor to predicting wildlife densities from trapping records is that some of the species (red squirrel, lynx, snowshoe hare) undergo marked fluctuation in numbers from year to year.

Despite the limitations described above, fur trapping records do give a crude estimate of relative abundances of furbearers in a particular region, and they do indicate which species are found there, either as permanent residents or transient individuals. Table 2 is a summary of trapping harvest, by species, for the 1973-1982 period for the three traplines that cover the Crow Lake study area (Alberta. Fish and Wildlife Division n.d.).

Table 2

TRAPLINE INFORMATION FOR CROW LAKE AREA
NUMBER OF ANIMALS TAKEN IN TEN YEAR PERIOD
1973-1982

Species	Number of Pelts
American beaver	520
Bobcat	3
Coyote	42
Ermine/Weasel	386
Fisher	50
Red fox (cross)	10
Red fox (red)	15
Lynx	115
Marten	2
American mink	184
Muskrat	1 541
River otter	12
Showshoe hare	46
Squirrel	6 711
Wolf	14

SOURCE: Fish and Wildlife Division, Alberta Energy and Natural Resources.

NOTE: Information compiled for the three registered trapping areas which overlap the Crow Lake study area. The total area of these three traplines is about seven times the size of the study area.

Using data from Table 2 as a rough indicator, the six most abundant furbearers in the Crow Lake area are (in descending order): squirrel [including American red squirrel and northern flying squirrel (Glaucomys sabrinus)], muskrat (Ondatra zibethicus), American beaver (Castor canadensis), ermine (Mustela erminea) and weasel (Mustela spp.), American mink (M. vison) and lynx. Although the number of pelts of snowshoe hare is relatively low (46), it is probably much more common than indicated. Interviews with a local trapper substantiate some of the figures in Table 2. He notes that muskrat and beaver are quite abundant within the study area, with good populations of lynx and fisher and to a lesser extent, red fox (Vulpes vulpes) and coyote are present as well (Richard Cerny 1983 pers. comm.).

In the following discussion, most of the habitat information concerning beaver, muskrat, mink and otter is based on a 1979 AOSERP study of semi-aquatic furbearers in northeastern Alberta.

Beavers are a semi-aquatic species for which the following conditions constitute favourable habitat: continuous reliable water supply, water depth 0.9-1.5 m (minimum), and a supply of preferred food (aspen, balsam poplar, willow, white birch) within reasonable distance from their lodge (within 250 m of the bank, or 800 m along the water course). Although they will occupy both streams and lakes, in northeastern Alberta they tend to establish colonies along streams rather than in lakes or other open water bodies. Preferred stream habitat is along water courses that have a gentle gradient, a relatively wide floodplain, and flow through deciduous forest or shrubland habitat.

Within the Crow Lake area, there is a fair amount of favourable beaver habitat. Most of the beaver activity is along the well-defined streams which drain into the Crow Lake basin, particularly Crow Creek, south of Crow Lake, and along the streams east of Crow Lake. Figure 14 outlines these areas, as well as others which were located by air photo interpretation. Watercourses on the upland peatlands do not harbour as many beaver. Throughout the summer, numerous signs of beaver were noted along the major streams, usually in the form of dams which were being maintained. Most of the beaver dens were observed to be in streambanks rather than in lodges. In a few instances, active beaver lodges were noted on medium to small ponds in the center of the study area. Beaver activity in Crow Lake itself was low, although a beaver was seen swimming along the northeast arm of the lake. Beaver densities seem to compare favourably to those in the AOSERP study area, where a mean frequency of one lodge per 3.1 km of watercourse was noted.

Muskrats are opportunistic feeders which find optimum habitat in areas of abundant food supply consisting of emergent and submergent plants, especially common cattail (Typha latifolia) and bulrush species (Scirpus spp.). As semi-aquatic mammals they require relatively stable water depths of 0.8 m to 2.1 m that permit access beneath winter ice. In northeastern Alberta, muskrat habitat consists of weedy lakes, ponds, sloughs and sluggish streams, with highest population densities reached in freshwater marshes.

In the Crow Lake area, suitable muskrat habitat is limited. Most of the waterbodies in the south and east are surrounded by shrubby fen, rather than emergent vegetation. Marsh development is restricted to a few of the medium-sized waterbodies that lie within the Crow Lake basin and it is here that muskrats are most likely to occur. Within the study area, there may be some areas of high muskrat density as shown in Table 2. One local trapper indicates that they are fairly numerous along Crow Creek, south of Crow Lake (Richard Cerny 1983 pers. comm.). There may also be sizeable muskrat populations in some of the larger watercourses, especially where beaver are actively maintaining dams (Figure 14). No signs of muskrat were noted during the summer, although there was no attempt made to actively look for them.

While no signs of mink were observed throughout this study, trapping records indicate their numbers to be moderate (Table 2). They are semi-aquatic predators which can hunt in aquatic or adjacent terrestrial habitats utilizing small mammals, waterfowl, aquatic invertebrates, muskrat and fish as prey. In northeastern Alberta, mink are widely distributed and are associated with standing waterbodies and low gradient streams. Within the region they seem to prefer open riparian vegetation dominated by willow in which upland deciduous forests are close at hand, as they are noted to subsist mainly on small rodents caught in those areas. Within the Crow Lake area, mink are probably restricted to the same habitats occupied by muskrats and to a lesser extent, beaver.

Red squirrel is noted as the most common furbearer in the area. This is probably accurate, as there were numerous signs of their activity. Many middens were noted, especially in the mixedwood and coniferous forests.

Snowshoe hares are another common Boreal Mixedwood small mammal species, although their numbers can be quite cyclic. It is hard to accurately determine their numbers within the study area at present. While snowshoe hare favour swamp birch, alder, tamarack (Larix laricina), jack pine and aspen as food sources, they are known to prefer habitats which include treed peatlands, black spruce forests and willow communities (AOSERP 1980). Within the study area, their fecal pellets were most noted in the coniferous forests, while evidence of browse was concentrated in the black spruce peatland areas. In all probability, snowshoe hare are near a low in their cyclical population fluctuations, as the browse damage to shrubs and trees was much less than that noted in boreal forest habitats in other regions in northern Alberta (pers. obs.).

Wolves (Canis lupis) are known to inhabit the Crow Lake region. During the summer, a number of scats and tracks were seen along the forestry winter road near the cabin. On July 26, two separate wolves were sighted. The first, a black adult, was seen along a seismic line in peatlands south of Crow Lake. The second, sighted one hour later, was grey-brown, and observed in an upland pine forest, along the forestry winter road by the old forestry cabin (Figure 14). Their density in the study area is hard to estimate. One study near Fort McMurray gives a wolf density of one per 100 km^2 with an average

pack range of 1 000 km^2 (AOSERP 1976). The same study lists moose as a major dietary item (66 per cent) with beaver second in importance (28 per cent) and notes that wolves in the area are probably limited by population densities of the former species. Wolf/moose ratios of 1:20 are cited as being common for the area. Given that Crow Lake has at least a moderate moose density, the area should be able to support a good wolf population. Regional Surveys and field observations substantiate this (Alberta. Fish and Wildlife Division 1975). However, wolves are also opportunistic feeders and will eat whatever prey is available, thus their major prey species can vary from year to year (Sandra Myers 1983 pers. com.).

Coyotes were observed once along the highway and are usually present in the region (Richard Cerny 1983 pers. comm.) (Table 2). Apparently they favour more open habitat, and so are more common in the forest-agricultural fringe to the south near Wandering River.

A lynx skull was found along a stream bank near the east end of Crow Lake. The study area is probably good habitat for lynx, as they prefer a variety of terrain types, particularly mixedwood forests (pers. obs.) where much of their diet of small rodents is obtained. Trapping records indicate a fairly high local population, although its density relative to other furbearers may be exaggerated due to the desirability of lynx as a commercial fur species. However, local trappers do note lynx as being relatively abundant (Richard Cerny 1983 pers. comm.).

In northeastern Alberta, black bear favour deciduous and mixedwood forests, utilizing those habitats an average of 65 per cent of their time (AOSERP 1976). As these forest types cover 27 per cent of the study area, the area around Crow Lake has the potential to support a moderately large black bear population. A black bear was noted numerous times around the old forestry cabin, and a second one was sighted several kilometres southeast of Crow Lake on an upland knoll in a major peatland area. Bear sign was noted in a variety of habitats around Crow Lake: tracks in mixedwoods; feces in shrubby fen, mixedwood and coniferous forests; and diggings in aspen and mixedwood forests. Regionally, black bear have been noted to reach densities as high as one per three square kilometres (AOSERP 1976).

There are a number of other species (e.g., bobcat (Lynx rufus) and red fox) listed in Table 2. None of these species were noted during this study, although they all likely occur, at least in low densities, or as transients, within the Crow Lake area.

5.4 Small Rodents

The most abundant small rodents within the boreal forest in northeastern Alberta are deer mice (Peromyscus maniculatus), Gapper's red-backed voles (Clethrionomys gapperi) and meadow voles (Microtus

pennsylvanicus) (RRCS 1975c). Deer mice were the only small rodents observed during the course of this study.

Small rodents provide the staple prey base for a number of important carnivores in the Crow Lake area such as weasels and mink, and to a lesser extent marten, fisher and coyotes. The greatest density and diversity of these species occurs in deciduous forests particularly in balsam poplar stands (RRCS 1974). This latter community type is not abundant at Crow Lake, but other preferred habitats are. Gapper's red-backed voles and deer mice are also known to favour willow and other early successional communities, while the former rodent also has high densities in jack pine stands. Most of the favourable habitats of these species are found in the upland areas around Crow Lake. Actual occurrences and population densities are unknown.

In addition to these major species, the following are other rodents (excluding commercial furbearing species previously mentioned) found locally throughout the boreal forest in northeastern Alberta (AOSERP 1980), and which may be present at Crow Lake: Pigmy shrew (Microsorex hoyi), masked shrew (Sorex cinereus), arctic shrew (S. arcticus), dusky shrew (S. obscurus), heather vole (Phenacomys intermedius), northern bog lemming (Synaptomys borealis), meadow jumping mouse (Zapus hudsonius) and least chipmunk (Eutamias minimus).

5.5 Fish

Waterbodies within the study area most likely to contain sport fish are Crow Lake and the two next-largest lakes (Figure 12).

Crow Lake is known as a fishing spot, however, there appear to have been no surveys carried out to date to determine its sport fishing resources. On a regional basis, Crow Lake compares favourably with other similarly-sized lakes in terms of fish habitat (Bradley 1969). Due to its location in a well defined glacially-scoured basin and the steepness of the slopes bordering its shores, Crow Lake is probably relatively deep. This has been somewhat substantiated by comments from local fishermen. The lake does contain broad shallow littoral zones, especially at the northeast and southwest ends. The combination of these two conditions results in a favourable habitat for several sport fish species (Bradley 1969).

In lakes of similar morphology in the region, some or all of the following species have been reported: northern pike (Esox lucius), yellow perch (Perca flavescens), cisco (Coregonus artedii), lake whitefish (Coregonus clupeaformis), walleye (Stizostedion vitreum), suckers (Catostomus spp.) and burbot (Lota lota) (Bradley 1969, Turner 1968). The first four species are the most common, and have been found in lakes seven kilometres deep and half the size of Crow Lake (Bradley 1969). Hence, they probably also occur in Crow Lake.

Sport fishermen indicate that northern pike are plentiful and yellow perch are reported to occur in the northeast corner of Crow Lake. There may be other species present, but this has not been substantiated.

Many of the streams in the eastern and southern upland portions of the study area are slow-moving, turbid watercourses, flowing through peatland areas. These conditions are not conducive to the presence of sport fish (Griffiths and Ferster 1974). However, once the streams draining into the Crow Lake basin descend over the valley breaks, their gradient and turbulence increases. If there are any stream fish in the study area they will be in those reaches. This, however, has not been investigated.

In 1974, Griffiths and Ferster conducted a fish survey on the House River, about two kilometres downstream of its confluence with Crow Creek about three kilometres west of the study area. They identified the following species: mountain whitefish (Prosopium williamsoni), spoonhead sculpin (Cottus ricei), brassy minnow (Hybognathus hankinsoni), lake chub (Couesius plumbeus), trout-perch (Percopsis omiscomaycus), white sucker (Catostomus commersoni) and longnose sucker (Catostomus catostomus). The last four species, as well as Arctic grayling (Thymallus arcticus) were also noted in some of the nearby tributaries, but Crow Creek was not surveyed. The presence of numerous fish species in these stream reaches is related to the following favourable habitat conditions: a sequence of shallow riffles and deep pools, gravel bottom, good shade cover from bankside trees, relatively clear water, fairly steep channel gradient and adequate nutrients (Griffiths and Ferster 1974, Turner 1968). Within the study area, the only water course reach that appeared to have these characteristics was along Crow Creek, for a distance of one kilometre from where it exits Crow Lake. This reach may support some of the above-mentioned fish. A few of the other tributaries may also have suitable sport fish habitat, but none were noted. As a whole, the study area has limited favourable stream conditions for sport fish.

6. FLORA

6.1 Composition

The Crow Lake study area lies well within the boundary of the Boreal Mixedwood Section, which is reflected by the numbers and composition of vascular species found there. Based on this and earlier studies, the vascular flora known within the study area consists of 260 species distributed among 140 genera and 55 families. Genera-rich families include: Compositae (12), Gramineae (11), Ericaceae (7), Rosaceae (7) and Ranunculaceae (7). The genera with the most species recorded are Carex (24), Salix (12), Ranunculus (7), Equisetum (6) and Lycopodium (5). Appendix 9.1 is an annotated vascular species list for the study area.

Throughout the study area, 57 moss species and eight liverwort species were noted, distributed among 30 genera. As well, 24 species of lichens representing seven genera were recorded. Additional information on these species is found in the annotated nonvascular lists (Appendix 9.2 for moss and liverwort species, Appendix 9.3 for lichens). Habitat information concerning the less common or visible nonvascular species was mostly derived from collections made within sampled communities. In some cases their abundance may be more widespread than was noted. There are probably more nonvascular species present in the area than were recorded.

Although their distribution and composition was not noted, some other nonvascular species such as bracket fungi and mushrooms are widespread and are most common in mesic, mature mixedwood stands. Common boreal epiphytes such as Evernia mesomorpha, Parmelia sulcata, Usnea spp., Hypogymnia physodes, Alectoria glabra and Ramalina spp. are most abundant in coniferous stands.

6.2 Significant Species

Eight vascular species reported as rare for Alberta were noted growing within the study site. The following is a list of such species, with a note as to the source [Packer and Bradley 1984 (P); Argus and White 1978 (A)]. Data on provincial distribution is taken from the range maps in Moss (1983).

Lycopodium sitchense Rupr. (A)
(ground-fir)
In one jack pine stand. Previously recorded from the mountain parks and Swan Hills region.

Carex loliacea L. (P)
(rye-grass sedge)
Recorded once along a moist streamside in mature spruce - fir forest. Distribution is sporadic throughout the boreal forest.

Carex scoparia Schk. (P)
(broom sedge)
Tentative identification from top of beaver dam. Recorded in Jasper National Park.

Carex trisperma Dewey (Pond A)
(three-seeded sedge)
One record from a poor fen. Its distributional range in Alberta is centered around the Swan Hills.

Carex vesicaria L. (P)
(blister sedge)
Occasional throughout in a variety of wet habitats -- poor fens, shore marshes. Distributed widely throughout Alberta.

Scirpus atrovirens Willd. var. pallidus Britt. (Pond A)
(green bulrush)
Found in wet habitats -- pond margins, herb meadows. Apparently rare in Alberta, reported from widespread locations.

Juncus filiformis L. (P)
(thread rush)
Occasional throughout on moist sites. Distributed sporadically in northern Alberta.

Pedicularis parviflora Smith (A)
(swamp lousewort)
Rare in boggy areas. Scattered records in north central Alberta.

There are other species which are common throughout the region but rare within the study area. These are listed as such in Appendix 9.

7. VEGETATION

Although the Crow Lake study area is quite large (151 km^2) most of the area was traversed during the field season. Consequently, the 76 sampled stands are spread throughout the study area (Figure 15). As well, data from previous studies were used to supplement the information obtained during the course of this study. In order to help with the ecological interpretation of vegetation around Crow Lake, two topographic cross-sections were made of the study area (Figure 16). These two cross-sections (Figures 17 and 18) help to illustrate the landform - vegetation relationship.

To contrast the vegetation in the study area with that of the region, a comparison is made of the area covered by the major vegetation types within the Crow Lake study area with that in the surrounding Stony Mountain Upland (Table 3). Appendix 10 contains a condensed summary of the amount of land covered by major forest types [based on Phase 3 forest inventory data (Alberta. Alberta Forest Service 1983)]. Figure 19 is a vegetation map of the study area at a scale of approximately 1:67 000 (reduced from an original map at 1:50 000.

7.1 General Description

The Crow Lake study area is characterized by a variety of terrain systems (see section 4) which allows a diversity of vegetation types to occur. Most of the upland and wetland plant community types which are found within the Boreal Mixedwood Section are represented at Crow Lake. Generally, the study area can be considered as two units, each comprising a specific landscape with associated vegetation. The first consists of the flat upland terrain surrounding the Crow Lake basin (Terrain System I and part of III - Figure 13). It is characterized by large peatland expanses intermixed with coniferous forests of *Pinus banksiana* and *Picea mariana* (Figure 19). The second area encompasses the more hilly topography within the Crow Lake basin (Terrain Systems II, IV, V and parts of III - Figure 13). It is characterized by upland coniferous, deciduous and mixedwood forests.

The Crow Lake study area is noted for the large amount of upland forests that it contains. Within the study area boundaries, 68.6 per cent of the land is covered by upland forests (called

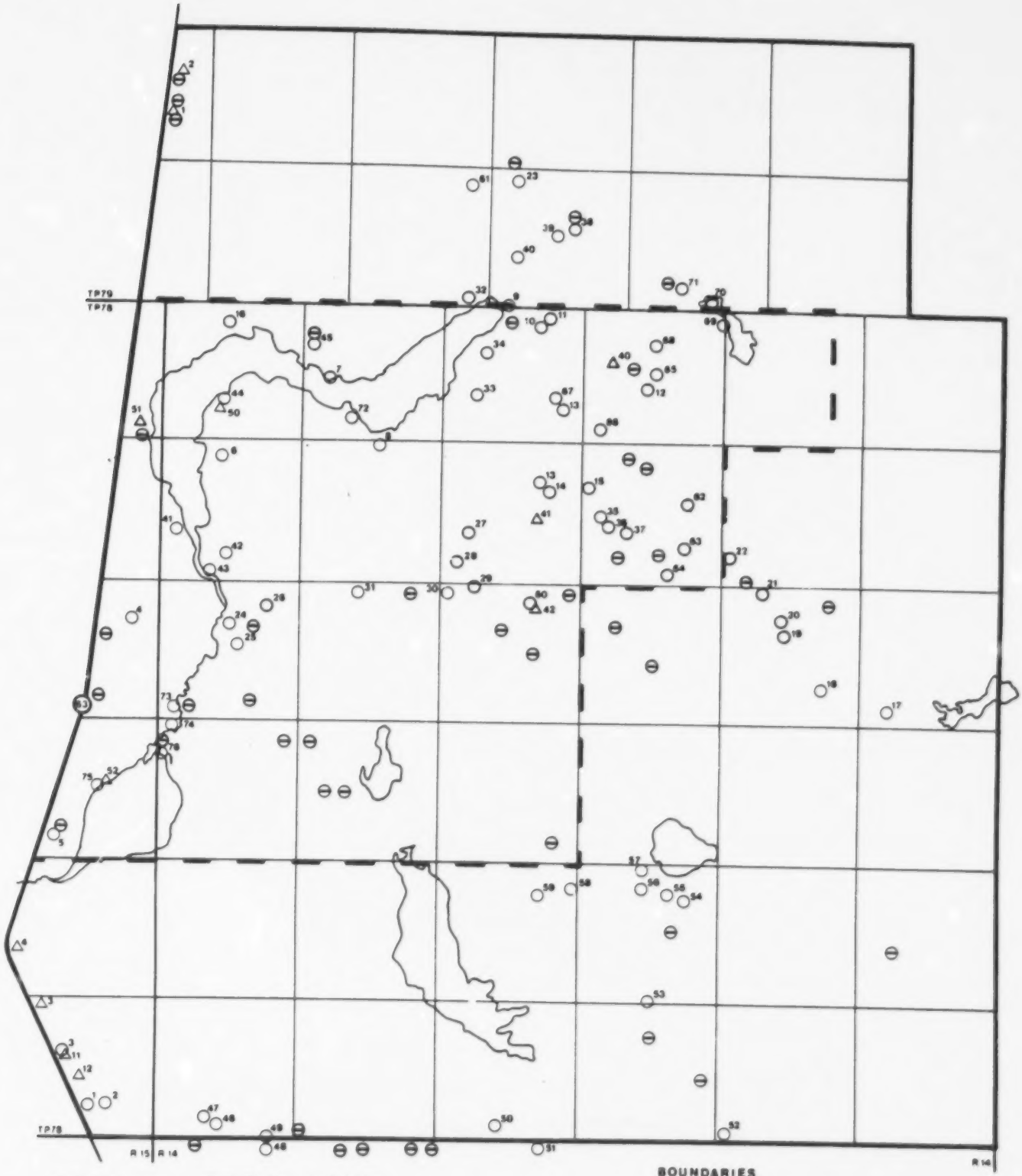


FIGURE 15 **CROW LAKE STUDY AREA**
PLANT COMMUNITY STUDY SITES

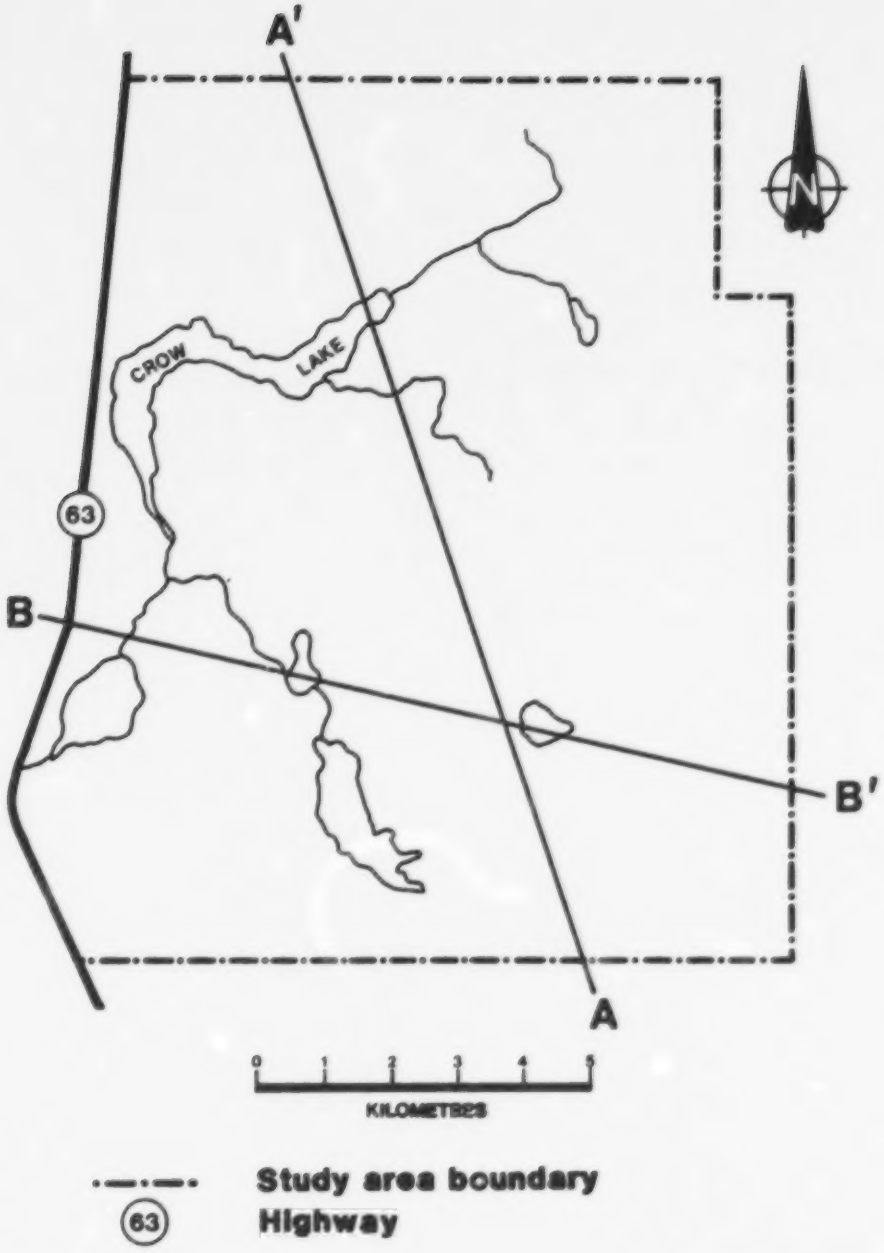
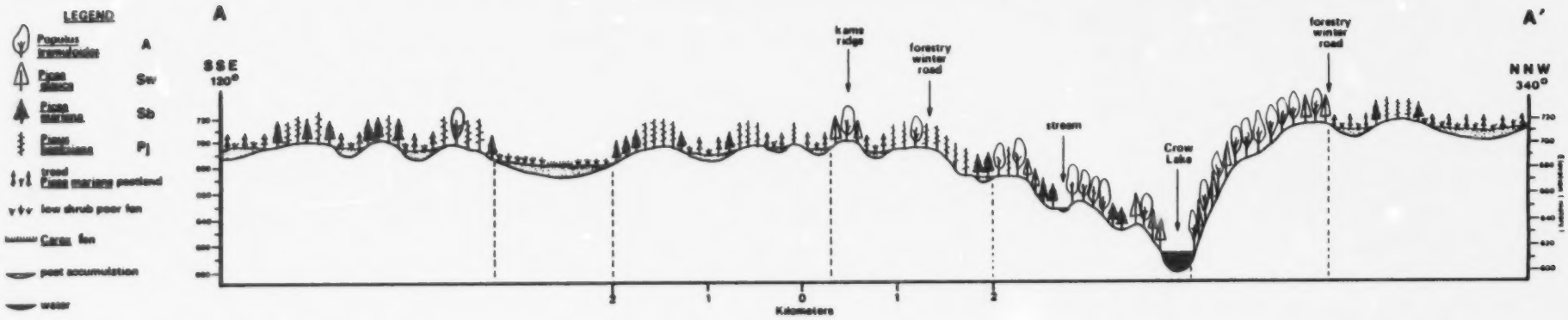


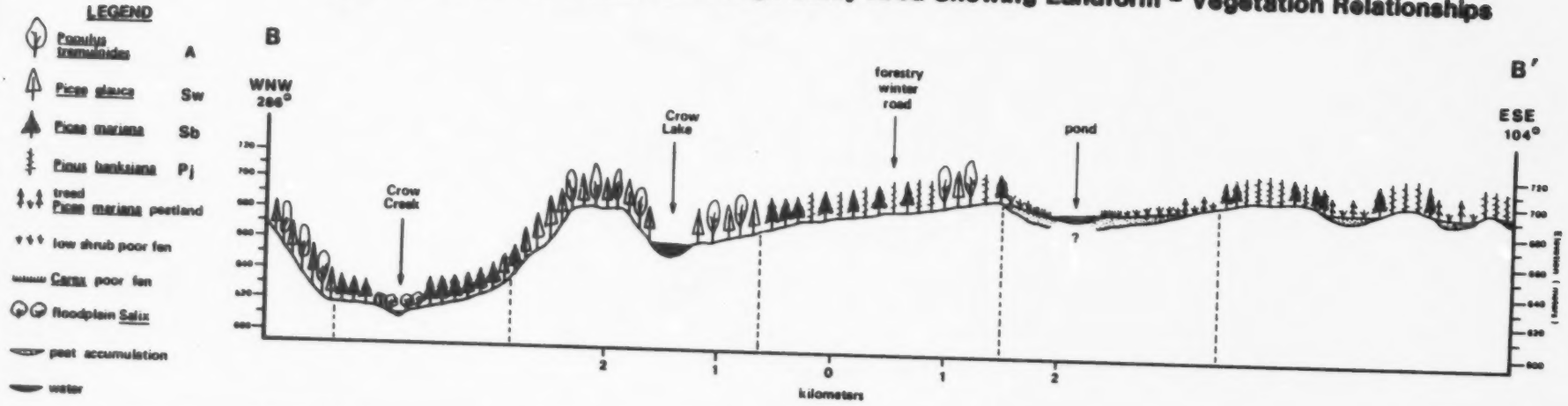
Figure 16 **Location of Cross-Sections Showing Landform-Vegetation Relationships**

Figure 17 Cross - Section through Study Area Showing Landform - Vegetation Relationships



VEGETATION TYPE	mosaic of upland Sb and Pj stands, interspersed with open treed Sb peatlands	shrubby poor fen and Carex fen	mixture of upland Pj and Sb stands interspersed with open treed Sb peatland	Pj forests, some A minor depressions	mixed Pj, A, Sw stands	A forest and mixedwood A Sw	mosaic of Pj and Sb stands on ridge, open treed Sb peatland in depressions
SLOPE	variable to flat	flat	variable to flat	gentle	moderate	steep	variable to flat
ASPECT	variable	no aspect	variable	NW	NW	SE	variable
DRAINAGE AND MOISTURE	well to moderately well drained ridges, poorly drained peatlands	poorly drained subhydric	well drained ridges, poorly drained peatlands	submesic	well to moderately submesic to mesic	moderately mesic	well drained on ridges, hygric, poorly drained peatlands
TERRAIN SYSTEM	Organic - Morainal Upland Complex Terrain System I		Organic - Morainal Upland Complex Terrain Systems I and III	Valley Glaciofluvial and Organic - Morainal Upland Complex	Valley Glaciofluvial Terrain System II		Organic - Morainal Upland Complex Terrain System I
SOIL	Eluviated Dystric and Eutric Brunisols Fibrisols in peatlands	Mesisols and Fibrisols	Eluviated Dystric Brunisols Fibrisols in depressions	Eluviated Dystric Brunisols Gleysols in depressions	Brunisolic Gray Luvisols and Eluviated Eutric and Dystric Brunisols	Brunisolic to Orthic Gray Luvisols	Eluviated Dystric Brunisols on ridges, Fibrisols in peatland

Figure 18. Cross - Section through Study Area Showing Landform - Vegetation Relationships



VEGETATION TYPE	A Sw mixedwood	closed Sb - feathermoss forest floodplain Salix swamp by stream	mature Sw on NW slope, SwA mixedwoods on remainder	mixtures of Sb and Pj woods	shrubby poor fen grading into Carex fen in wetter sites	mosaic of Pj and Sb stands on knolls, open treed Sb peatland in depressions
SLOPE	steep	gentle to flat	steep to level	gentle	flat	variable
ASPECT	SE	variable SE and NW on each side of valley	NW to SE	NW	no aspect	variable
DRAINAGE AND MOISTURE	mesic moderately well drained	mesic to imperfectly drained	moderately well drained mesic	moderately well drained submesic to mesic	hygric to subhydric poorly drained	subxeric to mesic on knolls, hygric poorly drained in depressions
TERRAIN SYSTEM	Glaciofluvial Meltwater Channel Terrain System IV		Dissected Moraine Terrain System V	Upland Glaciofluvial Organic Complex Terrain System III	Organic - Morainal Upland Complex Terrain System I	
SOIL	Eluviated Eutric and Dystric Brunisols		Brunisolic Gray Luvisols	Eluviated Eutric and Dystric Brunisols	Fibrisols and Mesisols	Eluviated Dystric Brunisols on knolls, Fibrisols in peatland

Table 3

AREA OF MAJOR VEGETATION TYPES:
COMPARISON BETWEEN CROW LAKE STUDY AREA AND SURROUNDING REGION

Vegetation Type	Crow Lake		Regional Average
	Hectares	% of Total Area	% of Total Area
Deciduous Forests (*Populus* spp., *Betula papyrifera*)	1 484.6	11.3	8.1
Coniferous Forests			
Picea mariana	2 537.9	19.4	1.1
Picea glauca	330.1	2.5	0.2
Pinus banksiana	1 409.5	10.8	2.8
Picea/Abies	54.8	0.4	no data
Picea/Pinus	581.2	4.4	20.6
Picea glauca and *P. mariana*	446.6	3.4	0.4
Total Coniferous	5 360.1	41.0	25.1
Mixedwoods			
Populus tremuloides - *Picea*	1 745.9	13.3	3.7
P. tremuloides - *Pinus*	248.5	1.9	3.1
P. tremuloides/*Picea*/*Pinus*	143.5	1.1	1.3
Total Mixedwood	2 137.9	16.3	8.1
Total Productive Forest	8 982.5	68.6	41.4
Coniferous Scrub (↑)	1 825.2	13.9	no data
Deciduous Scrub (↷)	161.9	1.2	no data
Open Muskeg (+)	742.4	5.7	no data
Treed Muskeg (↕)	470.5	3.6	no data
Burned in 1978	247.7	1.9	no data
Water	654.4	5.0	no data
Total Non-Productive	4 105.3	31.4	46.3
Other	3.2	< .01	12.3
Grand Total	13 088.0	100.00	100.00

SOURCE: Timber Management Branch, Alberta Forest Service, Department of Energy and Natural Resources, Edmonton.

Figure 19

VEGETATION OF THE CROW LAKE STUDY AREA

LEGEND

Forest

Sw	Picea glauca (White Spruce)
Pj	Pinus banksiana (Jack Pine)
Sb	Picea mariana (Black Spruce)
A	Populus tremuloides (Aspen)
Sb-Pj	Picea mariana - Pinus banksiana (Black Spruce - Jack Pine)
A-Sw	Populus tremuloides - Picea glauca (Aspen - White Spruce)
A-S-P	Populus tremuloides - Picea glauca - Pinus banksiana (Aspen - Spruce - Pine)
Sw-Fb	Picea glauca - Abies balsamea (White Spruce - Balsam Fir)
Sb-Sw-P	Picea mariana - Picea glauca - Pinus banksiana (Black Spruce - White Spruce - Pine)

Wetland

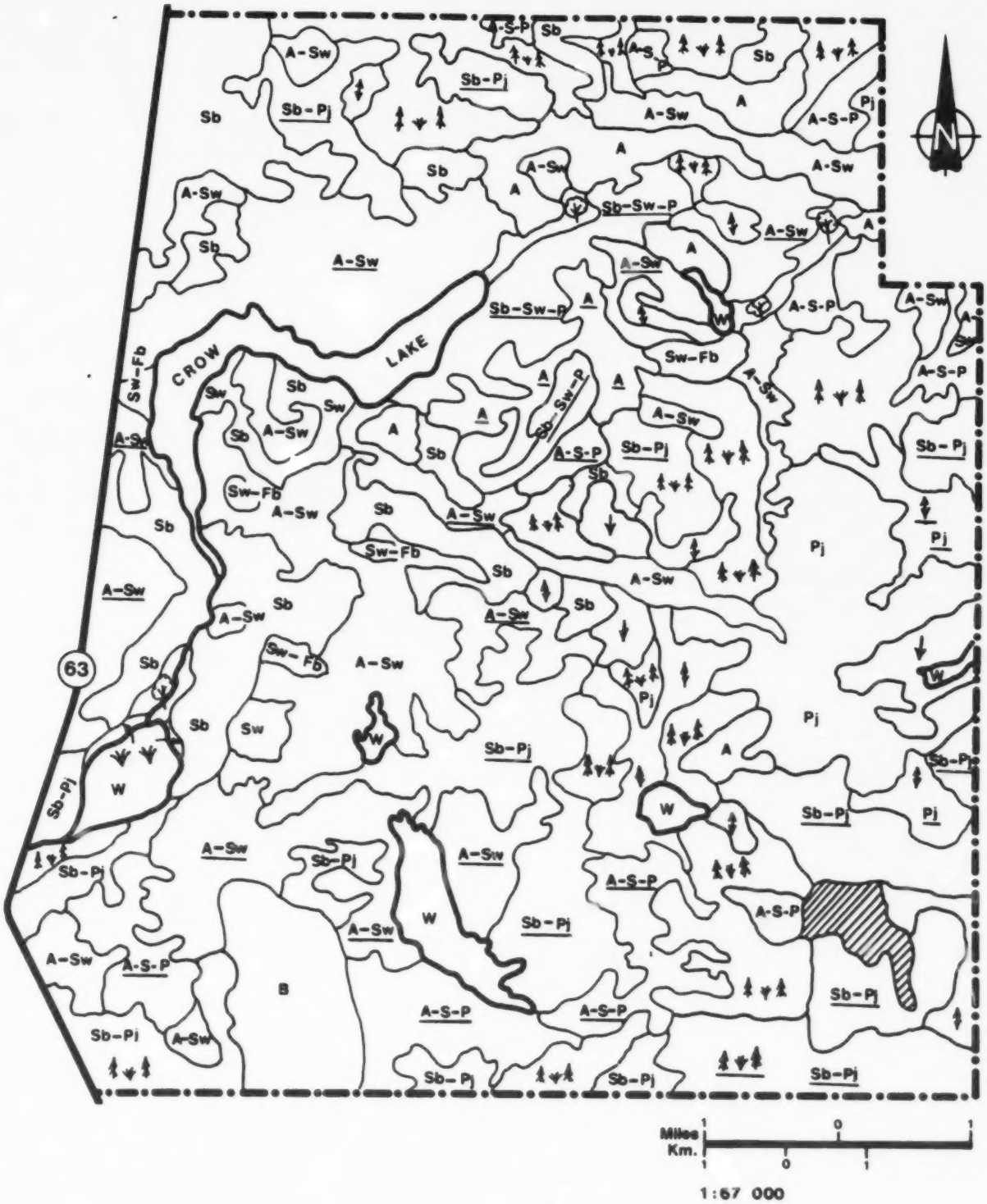
	Open Treed Picea mariana Peatland
	Shrubby Poor Fen
	Carex Fen
	Patterned Fen
	Marsh
	Swamp

Other

B	Burned in 1978
W	Water

Note: If a vegetation type is underlined on the map, it is a complex unit with constituent species often forming small pure stands.

Figure 19. Vegetation of the Crow Lake Study Area



NOTE: Crow Lake data derived from Phase 3 Forest Inventory Data, updated August 17, 1983. The area for each type is determined by combining the Phase 3 Units that have similar dominant canopy species.

Regional data compiled from Phase 2 Forest Inventory Data, updated January 1, 1970.

The regional averages for comparison with the Crow Lake vegetation type values were compiled in the following manner: Ten townships were selected at random in the House Plain subunit of the Stony Mountain Upland using the unpublished map by Pettapiece (n.d.). This is the physiographic unit where Crow Lake is located. The percentage of each township covered by a particular vegetation type was calculated for each township using the Phase 2 Forestry Inventory Data (last update January 1, 1970) available from the Timber Management Branch of Alberta Forest Service. The ten values were then averaged to give a regional average for each vegetation type. The data for the Crow Lake study area was compiled by computer summary of Phase 3 Forest Inventory Data for the area within the study boundaries.

The regional and Crow Lake values may not be directly comparable because the data is derived from different scaled maps: Phase 3 (1:15 000) and Phase 2 (1:31 680). Air photo interpretation of vegetation types at each scale may lead to different classifications. As well, the Phase 2 classification has a substantial percentage of the land area (12.3%) which is not classified, while in the Phase 3 data, all land is put in a category.

Notwithstanding the above limitations, Table 8 gives an approximate comparison between the Crow Lake study area and the surrounding region, in terms of percentage cover of each vegetation type.

"productive forest" in Table 3) as compared to 41.4 per cent for the region as a whole.

Coniferous forests are by far the dominant vegetation type within the study area, covering 41 per cent of the area (Figure 19). They are found in a variety of sites, from subxeric to hygric moisture conditions (Table 4), both within the Crow Lake basin, and in the surrounding upland areas. Picea mariana forests are the most prevalent, covering 19.4 per cent of the total study area (Table 3). They occur on the moister sites, in mesic to hygric conditions (Figures 17 and 18). These P. mariana forests are much more common around Crow Lake than in the region as a whole, as they cover only 1.1 per cent of the latter area. Pinus banksiana forests are also common at Crow Lake (covering 10.8 per cent of the study area versus 2.8 per cent of the Stony Mountain Upland) and occur on the drier, sandier sites (Tables 3 and 4, Figures 17 and 18). Although mature Picea glauca stands are an important feature in the Crow Lake basin, they cover only 2.5 per cent of the study area. This is still greater than the 0.2 per cent covered by P. glauca forests in the region as a whole.

Deciduous forests cover 11.3 per cent of the study area. Consisting mostly of Populus tremuloides with minor amounts of P. balsamifera and Betula papyrifera, they occur on submesic to mesic sites in the undulating topography around Crow Lake (Figures 17, 18 and 19).

Mixedwood forests consisting of varying mixtures of Populus spp., Picea spp., Betula papyrifera and Pinus banksiana cover 16.3 per cent of the study area.

Large tracts of treed Picea mariana peatlands (called "coniferous scrub" in Table 3) are found in the poorly-drained eastern and southern portions of the study area (Figures 17, 18 and 19). They comprise the largest wetland vegetation type, covering 13.9 per cent of the study area.

Other wetland vegetation types are found in smaller amounts. Some areas of low shrub and Carex fen (covering 6.2 per cent and 2.3 per cent of the study area, respectively) are situated in the south-central portions of the study area (Figure 19). A small poorly developed patterned fen is located in the southeast corner of the study area. Marsh vegetation is limited in the Crow Lake area. It is restricted to some small areas along the shores of some of the larger waterbodies. Shoreline and floodplain Salix swamps are also restricted in area, covering less than 1.5 per cent of the study area. They are confined to the wetland habitats within the Crow Lake basin.

Table 4

CONIFEROUS FOREST TYPES ALONG A MOISTURE GRADIENT

Dry ---------- Moisture Gradient ---------- Wet

Canopy Dominants	*Pinus banksiana*	*Pinus banksiana*	*Pinus banksiana* - *Picea mariana*	*Picea mariana* some *Pinus banksiana*	*Picea mariana*	*Picea mariana*	*Picea mariana*
Moisture and Drainage	subxeric, well drained	submesic, moderately well drained	mesic, moderately well drained	mesic, moderately well drained	mesic, moderately well drained	subhygric, imperfectly drained	subhygric to hygric, imperfectly to poorly drained
Site Position	slope crest	upper slope and crest	upper slope and crest	low ridge slopes	intermediate slopes	lower slope to shallow depressions	broad shallow depressions
Canopy Coverage	open	open	closed, occasionally open	closed, occasionally more open	closed	variable, but mostly open	open and sparse
Microtopography	level	level	level	level	level	moderately hummocky	very hummocky
Dominant Species in Tall Shrub Layer	none	*P. banksiana* *P. mariana*	*Picea mariana*	*Picea mariana* *Salix bebbiana*	none	*P. mariana*	*P. mariana*
Dominant Species in Low Shrub Layer	none	sparse cover	sparse cover	*Picea mariana*	none	*P. mariana*	*P. mariana*

Dominant Species in Herb-Dwarf Shrub Layer	*Vaccinium myrtilloides* *Arctostaphylos uva-ursi*	*Vaccinium myrtilloides* *V. vitis-idaea*	*Vaccinium myrtilloides* *Cornus canadensis*	*Vaccinium vitis-idaea* *V. myrtilloides*	*Ledum groenlandicum* *Vaccinium vitis-idaea* *Cornus canadensis*	*Ledum groenlandicum* *Vaccinium vitis-idaea* *Rubus chamaemorus*	*Ledum groenlandicum* *Rubus chamaemorus* *Vaccinium vitis-idaea*
Dominant Species in Bryoid Layer	*Cladina mitis*	*Cladina mitis* *Pleurozium schreberi*	*Pleurozium schreberi* *Cladina mitis*	*Pleurozium schreberi* *Hylocomium splendens* *Cladina mitis*	*Ptilium crista-castrensis* other feathermosses	*Pleurozium schreberi* *Cladina mitis* *Sphagnum* spp.	*Sphagnum fuscum* *Sphagnum angustifolium*
Community Type	*Pinus banksiana* - heath	*Pinus banksiana* - lichen - feathermoss	*Pinus banksiana* - *Picea mariana* transition	moderately closed *Picea mariana* - feathermoss	closed *Picea mariana* - feathermoss	open *Picea mariana* peatland transition	open treed *Picea mariana* peatland
Coniferous Forest Type (refer to Table 5)	4	3	8	7	5	6	Open Treed Peatland Type 1 (Table 7)

7.2 Upland Vegetation

In the present study, the upland (referring to moisture class rather than elevation) vegetation was classified into 16 community types within three forest, one open slope and one upland shrub units (Table 5). The Coniferous Forest Unit is comprised of nine community types. Three and two community types make up the Deciduous Forest Unit and the Mixedwood Forest Unit, respectively. The Open Slope Unit and Upland Willow Unit are each made up of one community type.

7.2.1 Coniferous Forest Unit

Picea glauca / Linnaea borealis - Cornus canadensis / Feathermoss Community Type 1 (White Spruce / Twin-flower - Bunchberry / Feathermoss).

This community type is found on mesic, moderately well-drained sites, often on moderately steep (5-12 per cent) upper to lower slope positions with a northeast to west aspect. Stands found on south-facing slopes are usually on flatter terrain.

These *Picea glauca* stands are best developed on loamy sands to sandy loams within the valley glaciofluvial terrain unit (Terrain System II - Figure 13) in which Eluviated Dystric Brunisols are the dominant soil type. They occur on cool, moist, north-facing slopes of the Crow Lake basin, where a longer fire-return interval allows mature stands to develop (Figure 17). This community type is widespread throughout the Crow Lake basin, however, the stands are usually small, often occurring within a larger mixedwood unit. Forest inventory data indicate that they cover about three per cent of the study area (Alberta. Alberta Forest Service 1983) (Tables 3 and 5).

The *P. glauca* stands are often quite old, dating back at least 140 years, and are tall (average ht. = 23 m) (Alberta. Alberta Forest Service 1983) with moderate deadfall (average of seven per cent cover). (Mensuration data on selected trees is found in Table 6.) Due to the uneven canopy coverage, light intensity at the forest floor is quite variable, resulting in a mosaic of ground cover, with maximum herbaceous cover under canopy openings.

Picea glauca is the dominant species of the tree stratum with an average cover in the three sampled stands of 39 per cent. *Populus tremuloides* is often present in small amounts (six per cent average cover). *Betula papyrifera* usually forms an open lower tree stratum (four per cent average cover). In these old growth forests, *Abies balsamea* often comes in as a late successional species. It is often present in the tree stratum in small amounts (four per cent average cover), can reach heights of 22 m, and attains ages of 115+ years. As well, *A. balsamea* can form a dense understory stratum due to its ability for vegetative reproduction in the mossy forest floor of mature

Table 5

UPLAND PLANT COMMUNITY TYPES OF THE CROW LAKE STUDY AREA[1,2]

	Stand Numbers of Surveyed Communities	Corresponding Phase 3 Forest Inventory Units	Percentage of Study Area Covered (Total Area = 131 km^2)
7.2 Upland Vegetation			
7.2.1 Coniferous Forest Unit			
1) Picea glauca / Linnaea borealis - Cornus canadensis / feathermoss	6, 16, 31	Sw(A), Sw(P), Sw	2.5
2) Picea glauca - Abies balsamea / Abies balsamea / feathermoss	4	SwFb(A), FbA	0.5
3) Pinus banksiana / Vaccinium vitis-idaea - V. myrtilloides / Cladina mitis - Pleurozium schreberi	15, 18, 33, 54	P(Sb), P(Sw)	2.8
4) Pinus banksiana / Vaccinium myrtilloides - Arctostaphylos uva-ursi / Cladina mitis	52	P, P(A)	7.8
5) Picea mariana / Ptilium crista-castrensis	24, 44, 72	Sb(Sw), Sb, Sb(A), SbSw, SbSw(A), SbSw(P)	15.8
6) Picea mariana / Ledum groenlandicum / Pleurozium schreberi - Cladina mitis - Sphagnum spp.	11, 26, 28, 34, 61		
7) Picea mariana / Vaccinium myrtilloides - Vaccinium vitis-idaea / Pleurozium schreberi	35, 43, 47, 50, 58	Sb(P)	7.0
8) Picea mariana - Pinus banksiana / Vaccinium myrtilloides - Cornus canadensis / Pleurozium schreberi	10, 37, 62, 63	PSb, SbP SbP(Sw), PSb(A)	3.6
9) Pinus banksiana - Picea glauca / Ledum groenlandicum / Pleurozium schreberi	70	PSw, PSw(A), SwP(A)	0.8
			Total 40.8

7.2.2 Deciduous Forest Unit			
1) *Populus tremuloides* / *Viburnum edule* - *Rosa acicularis* / *Aralia nudicaulis* - herb	12, 32, 53	A, A(P), A(Sw)	11.3
2) *Populus balsamifera* / *Amelanchier alnifolia* / *Epilobium angustifolium* - herb	23, 39	no units	1.0
3) *Betula papyrifera* / *Abies balsamea* / *Pleurozium schreberi*	8	Bw(Sw)	0.1
			Total 12.4
7.2.3 Mixedwood Forest Unit			
1) *Pinus banksiana* - *Populus tremuloides* / *Picea glauca* / *Vaccinium vitis-idaea* / *Pleurozium schreberi*	45, 5, 67	AP, AP(Sw), PA, PA(Sw), PA(Sb), ASwP, SwAP, SwPA, APSw, PASb, APSb, PASw(Sb), PSwA, ASwP(Sb)	3.2
2) *Populus tremuloides* - *Picea glauca* / *Abies balsamea* / *Viburnum edule* / *Cornus canadensis* - herb	25, 27, 30, 42, 65	SwA(Fb), ASw, ASw(P), ASw(Sb), ASb, SwA, SwA(P), ASwSb, ASbSw, SwSbA, SbASw	13.1
			Total 16.3
7.2.4 Open Slope Unit			
1) *Arctostaphylos uva-ursi* - *Vaccinium myrtilloides* - forb	38	no units	< 0.1
			Total 0.1
7.2.5 Upland Willow Unit			
1) *Salix bebbiana* - *S. pyrifolia* / *Calamagrostis canadensis* - herb	14	no units	< 0.5
			Total 0.5
			GRAND TOTAL 70.1

NOTE: [1] "Upland" refers to site moisture status, subxeric to mesic.
[2] The numbering system of the upland plant communities in this table corresponds to the numbering system in the text.
[3] Sw - Picea glauca (white spruce)
Sb - Picea mariana (black spruce)
Fb - Abies balsamea (balsam fir)
Pj - Pinus banksiana (jack pine)
Bw - Betula papyrifera (white birch)
( ) - less than 10% canopy cover

Table 6

TREE MENSURATION DATA FOR CANOPY SPECIES IN SELECTED PLANT COMMUNITIES

Vegetation Type	Stand No.	Species	Rings	Height (m)	Diameter (cm)	Remarks (trees are canopy unless stated otherwise)
Mature Picea glauca forest	6	P. glauca	107	18	16.5	average size (subcanopy)
	6	P. glauca	80	20	35	average size (subcanopy)
	31	P. glauca	125	25	54	largest trees
	16	P. glauca	120	25	47	largest trees
	31	A. balsamea	95	26	29	largest trees
	6	A. balsamea	97	25	24	largest trees
Picea glauca - Abies balsamea forest		P. glauca	120+	26	40	average size
		A. balsamea	70+	22	28	average size
		A. balsamea	78	22	27	average size
		A. balsamea	69	19	24	average size
Pinus banksiana woods	18	P. banksiana	50	17	23	average size
	33	P. banksiana	60	15	20	average size
	54	P. banksiana	87	16	27	average size
	54	P. banksiana	125	19	30	large size
	15	P. banksiana	67	19	30	large size
Picea mariana - feathermoss forest	72	P. mariana	120+	18	19	average size
	44	P. mariana	86	15	14	average size
	24	P. mariana	86	15	14	average size
Open Picea mariana peatland transition	11	P. mariana	88	9	12	average size
	26	P. mariana		7	10	average size
	34	P. mariana		8	10	average size
Picea mariana - feathermoss forest (minor component of Pinus banksiana)	47	P. mariana	61	16	14	average size
	50	P. mariana	115	19	18	average size
	35	P. mariana	65	9	11	subcanopy
	35	P. banksiana	50	12	21	average size
	47	P. banksiana	93	18	27	average size
	50	P. banksiana	90	24	28	large size

Table 6
(cont'd)

Vegetation Type	Stand No.	Species	Rings	Height (m)	Diameter (cm)	Remarks
Picea mariana - *Pinus banksiana* forest	37	*P. banksiana*	82	15	17	average size
	62	*P. banksiana*		13	18	average size
	63	*P. banksiana*	77	14	16	average size
	37	*P. mariana*		15	16	average size
	62	*P. mariana*	72	12	14	average size
	63	*P. mariana*	53	12	13	average size
Mesic herbaceous *Populus tremuloides* forest	12	*P. tremuloides*	70	24	23	average size
		P. tremuloides		22	40	average size
		P. tremuloides		20	16	average size
Populus tremuloides - *Populus balsamifera* forest	23	*P. tremuloides*		25	21	average size
		P. balsamifera		27	27	average size
Betula papyrifera woods	8	*B. papyrifera*		19	21	average size
Pinus banksiana - *Populus tremuloides*/ *Picea glauca* mixedwoods	45	*P. banksiana*	78	18	31	average size
	67	*P. banksiana*	56+	20	23	average size
	5	*P. banksiana*		18	19	average size
	45	*P. tremuloides*		15	25	average size
	67	*P. tremuloides*		16	18	average size
	5	*P. tremuloides*		19	14	average size
	67	*P. glauca*		13	12	average size
	5	*P. glauca*		14	13	average size
Populus tremuloides - *Picea glauca* mixedwoods	65	*P. tremuloides*		31	44	large size
	25	*P. tremuloides*	80+	27	34	average size
	30	*P. tremuloides*		28	40	average size
	42	*P. tremuloides*	96+	28	37	average size
	65	*P. glauca*	90+	30	46	average size
	25	*P. glauca*	97	28	29	average size
	30	*P. glauca*		33	59	average size
Open treed *Picea mariana* peatland	51	*P. mariana*	81	9	10	average size
	46	*P. mariana*	70	6	7	average size
	21	*P. mariana*		8	9	average size

Picea stands. The amount of Abies regeneration is quite variable from site to site with a high of 35 per cent cover reported for the tall shrub stratum in stand 31 (Appendix 11). In other stands, Abies is practically absent from the understory (e.g., stand 6, three per cent cover).

Cover of the herb-dwarf shrub layer is variable (3-30 per cent) but is generally at the lower end of the range. Dominant species and their average cover values are Linnaea borealis (twin-flower) (three per cent), Cornus canadensis (bunchberry) (three per cent) and Rubus pubescens (dewberry) (two per cent). In sites with more open tree canopies, Viburnum edule (low-bush cranberry) and Rosa acicularis (prickly rose) are the dominant low shrub species.

The feathermoss cover is high (average of 76 per cent) and ranges from 100 per cent in the more shady locations to 65 per cent under tree canopy openings. Pleurozium schreberi is dominant (33 per cent) followed by Hylocomium splendens and Ptilium crista-castrensis each with an average cover of 18 per cent.

Numerous authors (e.g., Van Groenewoud 1964; Kabzems et al. 1976) have described Picea glauca forests within the Boreal Mixedwood Section similar to those found at Crow Lake. Moss' (1953) shrub - herb faciation is similar to the more open P. glauca stands around Crow Lake.

The feathermoss faciation described by Moss (1953) and Van Groenewoud (1965) is comparable to the more shady, mossy stands within the study area, except that these authors note more Equisetum spp. (horsetail) in their stands. Raup's (1946) upland mesophytic Picea glauca forests differ from those at Crow Lake because the former have Salix bebbiana (beaked willow) in the tall shrub stratum.

Picea glauca - Abies balsamea / Abies balsamea / Feathermoss Community Type 2 (White Spruce - Balsam Fir / Balsam Fir / Feathermoss).

This community type can be divided into two associations. The first type (stand 4, Appendix 11) is a dense, medium-aged stand in which Picea glauca and Abies balsamea are co-dominant, each with 30 per cent cover, in an even canopy height of 14 m. There are no other woody strata, and deadfall is minimal. Herbaceous vegetation is sparse (four per cent cover). There is a continuous bryoid carpet composed of equal amounts of the three feathermoss species, Pleurozium schreberi, Hylocomium splendens and Ptilium crista-castrensis.

This community type appears to be anomalous for the study area, occurring only once, according to Phase 3 Forest Inventory data (Alberta. Alberta Forest Service 1983). It may have originated after a fire, in which seed dispersal from nearby mature stands allowed both tree species to germinate at the same time.

The second Picea - Abies association is much more common. It differs from the first in that it is a mature Picea - Abies community type in which active Abies regeneration is occurring. Although stands of this type were not surveyed using the Natural Areas Program stand

sheets, numerous observations were made. This community type represents the climatic climax association on mesic sites in the region, and succeeds mature Picea forests. Due to the length of time needed for its development and the relatively short fire-return interval in this area, this type of community is uncommon in the region (Rowe 1961), but is relatively abundant around Crow Lake. One such stand located on the west shore of Crow Lake has been surveyed previously (Ellis and La Roi 1978) and its presence contributes to the high preservation value of the Crow Lake area (Fairbarns 1979b).

Figures 19 and 20 show the location of the major Picea - Abies stands in the study area. They occur in habitats similar to those of the mature Picea glauca communities (mesic, moderately well-drained, north-facing, moderately steep slopes). Picea - Abies stands are fairly dense and usually have Picea glauca as the tree canopy dominant, although Abies can have cover values as high as 15-20 per cent. Picea outlive Abies, but the latter are able to reproduce abundantly under the forest canopy. This is reflected in the canopy structure in which most of the Picea are large individuals (at or above 25 m in height), while the Abies are slightly smaller (e.g., ht = 20 m, dia = 29 cm, age = 70+) (Table 6). Most of the canopy Abies show signs of disease, with split and rotting trunks. These stands all have high amounts of deadfall, usually around 20 per cent cover and may have dead standing Betula papyrifera trunks.

Abies regeneration is vigorous in most stands, and it is usually the only species in the low shrub to small tree strata. Cover values for Abies in the tall shrub stratum reach 50+ per cent. Picea regeneration is infrequent and localized. In a few localities where the tree canopy is more open, Vibernum edule is present, usually with less than five per cent cover.

Herbaceous cover is sparse (less than three per cent) with Cornus canadensis the most common species. Bryoid cover nears 100 per cent and is dominated by Hylocomium splendens and Ptilium cristacastrensis.

Forestry data indicates areal extent of the Picea - Abies community type to be 0.4 per cent of the study area (Table 3), however, field observations indicate it is probably closer to one per cent.

The Crow Lake Picea - Abies stands are similar to the Vibernum edule / Hylocomium splendens community type described by Achuff and La Roi (1977) except that the former have lower cover values for the understory species. Based on a continent-wide survey of Picea - Abies forests, La Roi (1967) proposes a preliminary classification based on understory species. His Abies - Populus / Rosa (rose) - Lonicera (honeysuckle) / Mertensia (lungwort) - Geocaulon (bastard toad-flax) - Vaccinium vitis-idaea (bog cranberry) community type is most similar to the Picea - Abies stands around Crow Lake. However, Lonicera and Mertensia are not common in the Crow Lake stands and Cornus canadensis is not a major component in the communities surveyed by La Roi.

Small depressions occasionally occur within the mature Picea - Abies forests such as in stand 6 (Figure 15). It is a 20 m wide opening in the forest, with a shallow 10 m wide pond in the center. Flora associated with this depression are: Calamagrostis canadensis (marsh reed grass), Ribes spp. (currants), Rubus strigosus (wild red raspberry), Trientalis borealis (star-flower), Dryopteris spinulosa (narrow spinulose shield fern), Marchantia polymorpha, Sphagnum teres and S. squarrosum.

Pinus banksiana / Vaccinium vitis-idaea - V. myrtilloides / Cladina mitis - Pleurozium schreberi Community Type 3 (Jack Pine / Bog Cranberry - Blueberry / Reindeer Lichen - Feathermoss).

This community type was sampled four times in the study. It is usually found on submesic, well-drained, sandy sites, on gentle to flat upper slopes and hill crests (Table 4). Stands are often fairly extensive and cover over seven per cent of the study area (Table 3). They are best developed on the sandy outwash along the forestry winter road south of Crow Lake and occur extensively on the drier outwash deposits in the southeast part of the study area (Figures 17, 18 and 19). As this community type develops best on glaciofluvial veneers, the common soil type is an Eluviated Dystric Brunisol or an Eluviated Eutric Brunisol, depending upon the pH of the material. The boundary between this upland vegetation and adjacent Picea mariana peatland can be very sharp. As these stands are of fire origin, they are usually even-aged at 50-80 years (Alberta. Alberta Forest Service 1983) (Table 6).

These stands are park-like, with an open canopy (30 per cent average cover) and sparse deadfall (three per cent cover). The main tree canopy is almost exclusively composed of Pinus banksiana and a second lower canopy is either not present, or composed of a sparse (approximately two per cent) cover of Populus tremuloides or Pinus banksiana. The tall shrub stratum is also somewht sparse (five per cent average cover) and is usually composed of P. banksiana and Picea mariana although Alnus crispa (green alder) is occasionally present.

There is a moderately dense layer of herbs and dwarf shrubs (36 per cent cover). Vaccinium vitis-idaea (bog cranberry) and V. myrtilloides (blueberry) are the co-dominants (14 per cent and T3 per cent average cover respectively), while on an average, Arctostaphylos uva-ursi (common bearberry) contributes six per cent cover. Cornus canadensis, Ledum groenlandicum (common Labrador tea) and Linnaea borealis all are less abundant (two per cent average cover). The dominant forb is Elymus innovatus (hairy wild rye) (0.2 per cent average cover).

The bryoid layer is dominated by an admixture of Cladina mitis (reindeer lichen) (42 per cent average cover) and Pleurozium schreberi (34 per cent average cover) with an average total cover of 79 per cent. Several other species are common, but with lower average covers: Cladina stellaris (1.5 per cent), Peltigera aphthosa (one per cent) and P. canina (one per cent).

Pinus banksiana / Vaccinium myrtilloides - Arctostaphylos uva-ursi / Cladina mitis Community Type 4 (Jack Pine / Blueberry - Common Bearberry / Reindeer Lichen).

Most of the Pinus banksiana stands around Crow Lake are composed of the submesic variety, which has a strong feathermoss component as discussed above (Coniferous Forest Type 3 - see Table 5). However, there is a variation that occurs on drier sites (Table 4). These stands are limited in area and probably cover less than 0.5 per cent of the study area. They are best developed on south-facing, subxeric, well-drained, sandy knolls. One such community was sampled during the field season (Stand 52, Appendix II).

The tree canopy tends to be more open (20 per cent average cover) than in the more mesic Pinus banksiana stands. Except for minor amount of Picea mariana in the understory in moister hollows, Pinus banksiana is the only woody species above the dwarf shrub layer. As with submesic Pinus forests, Vaccinium myrtilloides is one of the dominant dwarf shrubs (20 per cent average cover), however, unlike the latter, Arctostaphylos uva-ursi has a high cover as well (18 per cent average cover). Also important are Vaccinium vitis-idaea (10 per cent average cover) and Rosa acicularis (six per cent average cover). Elymus innovatus is relatively abundant (two per cent average cover) and the total average cover of the herb-dwarf shrub layer is 40 per cent.

Cladina mitis is overwhelmingly dominant in the bryoid stratum (80 per cent average cover), while Pleurozium schreberi is reduced to three per cent average cover in this drier community type as compared with an average cover of 34 per cent in mesic Pinus banksiana communities.

Carroll and Bliss (1981) describe Pinus banksiana stands on sandy soils in northeast Alberta which are similar to the stands around Crow Lake. The forests they describe however, are slightly more xeric, with a greater amount of Cladina spp. This is probably due to the fact that their stands are formed on extensive glaciofluvial outwash surfaces, whereas the drier Pinus banksiana stands in the study area occur on the south-facing slopes of smaller glaciofluvial ridges. These Crow Lake stands are surrounded by more moist community types which influence the species composition within the pockets of the most xeric P. banksiana stands.

Picea mariana / Ptilium crista-castrensis Community Type 5 (Black Spruce / Feathermoss).

Picea mariana - feathermoss forests are common throughout the study area. They are best developed on northeast- to northwest-facing, mesic, moderately well-drained slopes and usually occupy intermediate slope positions between mixedwood upland stands and lower wetland communities (Table 4). This type of forest is most dominant within the Glaciofluvial Channel (Terrain System IV - Figure 13), south of Crow Lake. Large stands also occur in the northwest part of the study area, and they are commonly found interspersed with Pinus banksiana

communities on small hummocks in peatlands in the southeastern portion of the study area (Figures 17, 18 and 19).

In most cases, this community type is located on glaciofluvial sands and the soils are Eluviated Dystric Brunisols. When underlying morainal deposits are covered with only a thin sandy veneer, then Brunisolic Gray Luvisols will develop (Soil Profile 25, Appendix 8B).

These forests are structurally and floristically quite simple. The closed tree canopy is composed almost exclusively of Picea mariana (55 per cent average cover). Most of the stands are even-aged, with slow growing trees, usually 90-100 years old (Table 6). Regeneration is light; P. mariana in the tall and low shrub strata has approximately two per cent average cover.

The herb-dwarf shrub layer is sparse with 14 per cent average cover. Ledum groenlandicum is dominant (eight per cent average cover), followed by Vaccinium vitis-idaea and Cornus canadensis (four per cent average cover for each). Although contributing an average cover of only one per cent, Equisetum sylvaticum (woodland horsetail) is always present.

Ptilium crista-castrensis is the dominant moss in these closed Picea mariana stands (45 per cent average cover). Combined with the two other feathermosses, Pleurozium schreberi and Hylocomium splendens, the average bryoid cover is almost 100 per cent.

Deadfall within these stands is moderate (eight per cent average cover) and indicates that these may be regenerating old-growth forests.

The forest inventory data indicates that there are substantial areas where Picea glauca is present along with the P. mariana, either as a canopy subdominant or codominant (Alberta. Alberta Forest Service 1983) (Appendix 10). This situation occurs on some of the better-drained slopes, especially around Crow Lake. Field reconnaissance, however, shows that often P. glauca is not as common as indicated, and where it does occur as a subdominant, it appears to have little effect on the community structure and floristics. The only difference noted from that of a pure P. mariana forest is the presence of minor amounts of Betula papyrifera (three per cent average cover) in the lower tree layer. As well, there is a tendency for a slightly higher herb-dwarf shrub cover with a greater prominence of Pleurozium schreberi in the bryoid layer. Stand 72 illustrates these slight differences (Appendix 11).

Picea mariana / Ledum groenlandicum / Pleurozium schreberi - Cladina mitis - Sphagnum spp. Community Type 6 (Black Spruce / Common Labrador Tea - Bog Cranberry / Feathermoss - Reindeer Lichen - Sphagnum).

This community type is transitional between upland closed Picea mariana forests (Coniferous Forest Type 5 - Table 5) and open Picea mariana peatlands (Open Treed Peatland Type I - Table 7) with structural and floristic affinities to both (Table 4). It is common on

subhygric, imperfectly-drained, lower slope to shallow depressional situations. Slope gradients are usually shallow, so aspect does not have a major influence on this community. It is found intermixed with closed P. mariana stands in the wetter areas throughout the Crow Lake basin. This community also occurs, to a lesser extent, along the margin of the open treed peatlands on the Organic-Morainal Upland Complex (Terrain System I - Figure 13) throughout the rest of the study area (Figure 19).

These imperfectly to poorly drained communities exhibit wide variability in the thickness of the underlying organic layer. Where they occur in shallow upland depressions and lower slope positions, the organic mat may be 25 cm thick. In this case, the soil is classed as an Orthic Gleysol, due to the gleying in the underlying usually sandy mineral soil (Soil Profile 15, Appendix 8D). This is probably the dominant soil in this community type throughout the study area. There may be a few cases where the organic mat is deep enough (one metre) to class the soil as a Fibrisol or Mesisol.

The cover of the P. mariana canopy is quite variable (7-65 per cent), however, on average it is fairly open (24 per cent average cover), composed of trees usually no more than 10 m in height (Table 6). Unlike the closed forest stands, this canopy is not even-aged. P. mariana has good distribution throughout all age classes and dominates all the woody strata: tall shrub layer -- 12 per cent average cover, low shrub layer -- 11 per cent average cover. Occasionally, Larix laricina is present in the understory as a minor species (one per cent average cover).

The herb-dwarf shrub layer is dominated, as in the drier Picea mariana stands, by Ledum groenlandicum. The average cover is somewhat higher in this community type (19 per cent) although it can be quite variable (3-30 per cent). Other species of peatland habitats such as Vaccinium vitis-idaea (five per cent average cover), Rubus chamaemorus (cloudberry) (three per cent average cover) and Smilacina trifolia (three-leaved Solomon's-seal) (two per cent average cover) are also present. Vaccinium myrtilloides, a species characteristic of drier forests is present in variable amounts from 0-15 per cent cover. Average ground cover in this stratum is moderate (34 per cent) as compared to the sparser cover in the closed forest type.

Within this community type, peat accumulation has resulted in a moderately hummocky microtopography. The bryoid cover is almost 100 per cent (96 per cent average cover) and is composed of a mosaic of different species. The feathermoss Pleurozium schreberi is dominant (50 per cent average cover, range 40-70 per cent) and occurs on mesic microhabitats. Cladina mitis can be quite variable in cover (range 3-50 per cent, average of 21 per cent) and dominates the drier hummocks along with Sphagnum fuscum (nine per cent average cover) and S. nemoreum (four per cent average cover). A third Sphagnum species, S. magellanicum is found in moderate amounts (six per cent average cover) in the moister inter-hummock depressions. Generally, the bryoid layer is species-rich (up to 17 species) with several Cladonia spp. present, each with low cover.

The closed Picea mariana - feathermoss forest (Coniferous Forest Unit 5) is not mapped separately from the open P. mariana transitional peatland forest (Coniferous Forest Unit 6) on the Phase 3 Forest Inventory 1:15 000 maps (Alberta. Alberta Forest Service 1983) (Table 5). Usually the latter type is classed as the former type. From the Forest Inventory data, both types combined cover about 16 per cent of the study area. Based on field observation, the closed forest type appears to be dominant, perhaps covering 10-13 per cent of the study area.

Picea mariana / Vaccinium myrtilloides - V. vitis-idaea / Pleurozium schreberi Community Type 7 (Black Spruce / Blueberry - Bog Cranberry / Feathermoss Community Type).

This community type is widely intermixed with the closed Picea mariana - feathermoss forests (Coniferous Forest Type 5), and can be quite extensive, covering approximately seven per cent of the total study area. It is usually found on mesic, moderately well- to well-drained, level to slightly-inclined slopes, usually with east or south aspects (Table 4).

These stands are usually found on low glaciofluvial and morainal ridges, throughout the study area. Modal soil types are Eluviated Eutric and Dystric Brunisols.

Canopy cover is variable, with P. mariana contributing an average cover of 46 per cent (range 35-68 per cent cover) and Pinus banksiana a canopy subdominant (average of four per cent, range two to eight per cent cover). This variability is due to the mosaic of moist and dry substrates on the undulating surface, with drier, more open areas having a greater cover of P. banksiana and associated species. The ages and heights of the canopy species can be quite variable, with ranges of 65-115 years and 9-24 m (Table 6).

Picea mariana cover ranges from 2-20 per cent in the tall shrub stratum (average of eight per cent) and has an average cover of four per cent in the low shrub stratum. The only other species of note in these strata is Salix bebbiana which is occasionally present as a tall shrub (height averages three metres) with cover up to five per cent (see stand 58, Appendix 11).

Cover in the herb-dwarf shrub layer ranges from 12-35 per cent (22 per cent average cover) and is dominated by the following species: Vaccinium myrtilloides (eight per cent average cover), V. vitis-idaea (eight per cent average cover) and Ledum groenlandicum (seven per cent average cover). Cornus canadensis is always present, with an average cover of five per cent.

Equisetum sylvaticum and Calamagrostis canadensis are often present, although in low amounts. Rosa acicularis can be locally more abundant on more open sites, reaching seven per cent cover in stand 50 (Appendix 11). However, it was not present in three of the five stands sampled.

Pleurozium schreberi is the dominant bryophyte (50 per cent average cover) followed by Hylocomium splendens (average of 19 per cent, range 0-35 per cent cover). Ptilium crista-castrensis and Cladina mitis both are quite variable in cover, with averages around 11 per cent. The latter species dominate the drier open patches. Other species which are often present in low amounts include: Cladonia spp., Polytrichum commune and Sphagnum nemoreum. Total bryoid cover averages 92 per cent.

Although this community type resembles the closed Picea mariana - feathermoss type (Coniferous Forest Type 5), it does differ in several respects (Table 4): more open canopy, minor presence of Pinus banksiana, somewhat denser shrub and herb-dwarf shrub strata and greater cover of Cladina mitis and Vaccinium myrtilloides which indicate slightly drier conditions.

Picea mariana - Pinus banksiana / Vaccinium myrtilloides - Cornus canadensis / Pleurozium schreberi Community Type 8 (Black Spruce - Jack Pine / Blueberry - Bunchberry / Feathermoss).

This mixed coniferous type is a transition between the dry, open Pinus banksiana forests (Coniferous Forest Type 3) and the closed mesic Picea mariana - feathermoss forests (Coniferous Forest Types 5 and 7) (Tables 4 and 5). Covering about four per cent of the study area (Table 3), it is most common on mesic, moderately well-drained, upper slope to slope crest positions. Aspect is variable, although slopes tend to be less than three per cent.

This community type is found throughout the Crow Lake area (Figure 19). It appears to be most commonly intermixed with pure Pinus banksiana stands (Coniferous Forest Types 3 and 4) on localized sandy deposits in the extensive peatland-morainal complex (Terrain System I - Figure 13). Soils are similar to those in the other coniferous forests.

The tree canopy is relatively closed, with an average cover of 58 per cent. Canopy trees are usually between 13-18 m in height, and 55-85 years old (Table 6). P. mariana is usually the dominant species (37 per cent average cover), however, Pinus banksiana is well represented with an average cover of 21 per cent. A second tree canopy is lacking, but Picea mariana often forms an open tall shrub layer (nine per cent average cover). This suggests that succession may be toward a closed P. mariana - feathermoss forest (Coniferous Forest Type 5). Throughout the study area, all stands where P. mariana and Pinus banksiana form the canopy, the latter species is lacking in the understory; P. banksiana regeneration has been noted on only a few of the drier sites. Most of the stands are even-aged and of fire origin.

In this community type Vaccinium myrtilloides is the dominant dwarf shrub (eight per cent cover). V. vitis-idaea (five per cent average cover), Rosa acicularis (two per cent cover) and Ledum groenlandicum (two per cent cover) are the other common shrubs. Cornus canadensis is the dominant herb with an average cover of six per cent. Epilobium angustifolium (fireweed), Elymus innovatus,, Linnaea borealis

and Campanula rotundifolia (bluebell) are other common species. The herb-dwarf shrub stratum is fairly open with 23 per cent average cover.

Pleurozium schreberi dominates the bryoid layer (47 per cent average cover), however, Cladina mitis has an average cover of 17 per cent, and is dominant in the open drier areas. It can be variable in cover, with a range of 2-25 per cent in the three communities sampled. Other feathermosses, Hylocomium splendens and Ptilium crista-castrensis, are common with 12 per cent and 11 per cent average cover respectively. Peltigera aphthosa, P. canina and Dicranum polysetum are present in lower amounts. Total bryoid cover averages 82 per cent.

The community sampled in stand 10 (Appendix 11) represents a variation from the modal type. It is much more open and drier than the above mentioned community type. Pinus banksiana and Picea mariana (12-15 m in height) are both present, but in greatly reduced amounts (six per cent and three per cent respectively). A lower open tree canopy of P. mariana occurs. A sparse herb-dwarf shrub layer (15 per cent cover) has a similar species composition to the closed forest type, but in reduced amounts. The presence of Arctostaphylos uva-ursi attests to the drier conditions. In this situation, Cladina mitis is the dominant bryoid species (65 per cent cover), while Pleurozium schreberi is reduced to 35 per cent cover. This drier variation of the Picea mariana - Pinus banksiana forest is restricted to sandy upper slopes.

Pinus banksiana - Picea glauca / Ledum groenlandicum / Feathermoss Community Type 9 (Jack Pine - White Spruce / Common Labrador Tea / Feathermoss).

This community type is restricted, covering less than one per cent of the study area (Appendix 10). It appears to be found mostly on the glaciofluvial deposits surrounding Crow Lake and in well-drained mesic situations. This type is quite variable and can change over short distances from pure Picea glauca, with mesic understory species to subxeric stands of Pinus banksiana. A variety of intermediate situations occur as well.

Only one stand was sampled in this type (stand 70, Appendix 11); it occurs on a five per cent slope with east aspect, east of Crow Lake (Figure 15). P. banksiana, 20 m in height, forms the dominant tree canopy species (50 per cent cover). A second canopy at 17 m is comprised of an open stratum of Picea glauca with 15 per cent cover. This species also forms a sparse tall and low shrub layer (four per cent and two per cent cover respectively) indicating that succession is toward a P. glauca-dominated community.

The moderately dense herb-dwarf shrub layer (35 per cent cover) is dominated by Ledum groenlandicum (20 per cent cover). Vaccinium vitis-idaea is second most important with 10 per cent cover. Other notable species include V. myrtilloides, Cornus canadensis, Vibernum edule, Maianthemum canadense (wild lily-of-the-valley) and Petasites palmatus (palmate-leaved coltsfoot).

With 70 per cent and 20 per cent cover respectively, two feathermosses, Pleurozium schreberi and Ptilium crista-castrensis

almost totally comprise the bryoid stratum. Dicranum polysetum, Hylocomium splendens and Peltigera canina contribute minor covers.

7.2.2 Deciduous Forest Unit

Populus tremuloides / Vibernum edule - Rosa acicularis / Aralia nudicaulis - Herb Community Type 1 (Aspen / Low-bush Cranberry - Prickly Rose / Wild Sarsaparilla - Herb).

Populus tremuloides forests occur on mesic, well- to moderately well-drained slopes of varying aspects. Although gradients are usually gentle, these stands are found on slopes as steep as 25-35 per cent. Most of the pure P. tremuloides stands are found on the undulating slopes leading down to Crow Lake (Figure 17). Small stands occur sporadically throughout the study area on mesic upland surfaces (Figure 19). This community type is usually found on glaciofluvial and morainal ridges. Within the study area boundaries, P. tremuloides forests occupy approximately 11 per cent of the total area (Tables 3 and 5).

P. tremuloides stands develop on a variety of substrates. They appear to grow best on finer-textured sandy loams, where glaciofluvial veneer is thin or nonexistent over the morainal ridges; the modal soil which forms is a Brunisolic Gray Luvisol. In many cases, these stands are formed on slightly coarser textured loamy sands, where Eluviated Eutric Brunisols are common. A few stands are associated with Eluviated Dystric Brunisols.

This community type is characterized by a multi-stratal structure, with relatively high species richness in each layer. Most P. tremuloides stands have a minor component of other tree species, at least in the understory. During this study, three stands of almost pure P. tremuloides were sampled (Appendix 11). These forests have a moderately closed canopy of 38 per cent cover on average. In two of the stands, P. tremuloides was the sole canopy species. In the third, Populus balsamifera and Picea glauca contributed 15 per cent and nine per cent cover respectively. Populus tremuloides in these mature stands range in height from 22 m to 26 m and are over 70 years old (Table 6). Occasionally, Betula papyrifera or Populus balsamifera will form an open lower tree canopy beneath the P. tremuloides, with cover values around eight per cent.

Alnus crispa, with an average cover of four per cent, is the dominant tall shrub. Average height of this stratum is three metres, with an average cover of seven per cent. Other species include Betula papyrifera, Picea glauca, Populus balsamifera, P. tremuloides and Salix bebbiana, which all contribute one per cent or less cover.

Cover in the low shrub layer (0.5 m to two metres height) is sparse (two per cent average cover) and composed mostly of taller individuals from the herb-dwarf shrub layer.

Vegetation in the herb-dwarf shrub stratum is lush and species-rich (25-30 species in a stand). The dominant shrubs and their average covers are Vibernum edule (15 per cent), Rosa acicularis (15 per cent), Rubus pubescens (seven per cent) and R. strigosus (two per cent). The herbs are numerous, and several may be co-dominant in any one stand. The most common species and their average covers include Aralia nudicaulis (wild sarsaparilla) (17 per cent), Cornus canadensis (seven per cent), Epilobium angustifolium (six per cent), Lathyrus ochroleucus (cream-coloured vetchling) (five per cent), Mertensia paniculata (tall mertensia) (five per cent), Pyrola asarifolia (common pink wintergreen) (three per cent), Vicia americana (wild vetch) (two per cent) and Aster conspicuous (showy aster) (three per cent). Actaea rubra (red and white baneberry), Calamagrostis canadensis, Equisetum arvense (common horsetail), Galium boreale (northern bedstraw), Linnaea borealis, Lonicera involucrata (bracted honeysuckle), Maianthemum canadense and Petasites palmatus are often present in smaller amounts. Total cover in this layer is high, ranging from 50 to 80 per cent (average of 70 per cent).

As a rule, bryophytes and lichens cover only two to three per cent of the ground surface, and are usually restricted to decaying woody substrates. Stand 12 (Appendix 11), which is north-facing and slightly more mesic than the modal site, has 30 per cent cover of Pleurozium schreberi. This is anomalous, as feathermoss cover usually equals only one to two per cent in most stands.

Due to the even-aged nature of many of these stands, and the small amount of deadfall (three per cent average cover), a fire origin is presumed. Unlike the mixedwood stands to be described later, the tree species which will eventually replace Populus tremuloides are often not present in the understory. However, in a few cases, Picea glauca and Abies balsamea up to three metres in height are present.

Populus tremuloides stands on south-facing slopes tend to have a less well developed shrub layer than those in moister sites. As well, although the herbaceous layer includes most of the species common to more mesic forests, it is slightly sparser, and grasses such as Elymus innovatus are more common. In the most sandy situations, the Populus tremuloides forests are less lush, and species such as Lycopodium complanatum (ground cedar) are present.

Populus bamsamifera / Amelanchier alnifolia / Epilobium angustifolium - Herb Community Type 2 (Balsam Poplar / Saskatoon-berry / Fireweed - Herb).

This community type was encountered occasionally in the Crow Lake site. It is quite restricted in area, covering less than 0.5 per cent of the study area, and is usually found as small patches within the Populus tremuloides forests (Table 3 and Appendix 10). P. balsamifera-dominated woods are found close to Crow Lake, on mesic, moderately well-drained southeast- to north-facing slopes, usually of moderate steepness (10-15 per cent slope).

Soils are relatively fine-textured sandy loams, often overlying clay loams in the C horizon. The modal soil type is a Brunisolic Gray Luvisol, with possible intermixes of Orthic Gray Luvisols.

These stands are structurally and floristically quite similar to the mesic herbaceous P. tremuloides woods. Only one stand in which P. balsamifera was the sole canopy species was surveyed, and is described below (stand 39, Appendix II).

The even-aged canopy is 16 m tall, with 65 per cent Populus balsamifera cover. Picea glauca (4 per cent cover) and Salix bebbiana (three per cent cover) are the dominant tall shrub species. The low shrub layer has only five per cent cover, mostly with S. bebbiana and Amelanchier alnifolia present.

The herb-dwarf shrub layer is rich with 37 species identified (cover values indicated in brackets). Amelanchier alnifolia (18 per cent), Rosa acicularis (10 per cent) and Rubus pubescens (five per cent) are dominant dwarf shrubs. Epilobium angustifolium (23 per cent), Viola rugulosa (western Canada violet) (nine per cent), Mertensia paniculata (seven per cent) and Delphinium glaucum (tall larkspur) (five per cent) are dominant herbs. Other species with covers between five per cent and two per cent in this stratum include: Actaea rubra, Calamagrostis canadensis, Aster ciliolatus (Lindley's aster), Equisetum arvense, Galium boreale, Lathyrus ochroleucus, Ribes triste (wild red currant), Thalictrum sparsiflorum (flat-fruited meadow rue) and Vicia americana. Total cover is 70 per cent.

The bryoid cover is only two per cent and consists mostly of species growing on rotting logs.

A second stand was sampled which was dominated by a mixture of mature, 25 m tall Populus tremuloides and P. balsamifera with 25 per cent and 20 per cent cover respectively (stand 23, Appendix II). Site characteristics were similar to those of the pure P. balsamifera community although the dominant species are somewhat different.

Alnus crispa (six per cent cover) dominates the tall shrub layer, while the low shrub layer has a cover of six per cent, with minor amounts contributed by several species. Aralia nudicaulis (14 per cent), Lonicera involucrata (12 per cent), Lathyrus ochroleucus (eight per cent), Vibernum edule (seven per cent), Actaea rubra (seven per cent), Mertensia paniculata (seven per cent), Poa palustris (fowl bluegrass) (six per cent) and Ribes triste (five per cent) are the major herb-dwarf shrub species (cover values in brackets). Total species richness is 29, with a combined cover of 70 per cent.

The bryoid layer has Plagiomnium cuspidatum (four per cent cover) and Pylaisiella polyantha (one per cent cover) as the major constituents.

This second stand is a transition between the mesic Populus tremuloides and pure P. balsamifera community types. All the mesic deciduous forests sampled have similar species compositions. Locally,

however, there is a wide variability in the cover values of most species.

Betula papyrifera / Abies balsamea / Pleurozium schreberi Community Type 3 (Paper Birch / Balsam Fir / Feathermoss).

Stands of pure Betula papyrifera are not common at Crow Lake. Those present are usually one to two hectares in size, and occur on north-facing, moderately steep slopes. Within the study area, they are found only in the eastern half of the Crow Lake basin, generally in association with mixedwood stands adjacent to the lake. The substrate is mesic and moderately well-drained.

Although soils were not sampled in the B. papyrifera communities, they are most likely Brunisolic Gray Luvisols (based on soil pits sampled in similar sites in Populus tremuloides stands).

In the one Betula community sampled (stand 8, Appendix 11), B. papyrifera is almost the sole tree canopy dominant (35 per cent cover), with an average height of 19 m (Table 6). An open lower tree canopy at 12 m is dominated by Abies balsamea (five per cent cover), B. papyrifera (five per cent cover) and lesser amounts of Picea glauca (two per cent cover). This succession toward coniferous forests has been noted for other Betula papyrifera stands in the area.

Abies balsamea, with five per cent cover, constitutes the tall shrub layer. Although the canopy is fairly open, the presence of the A. balsamea and the north aspect result in a fairly sparse herb-dwarf shrub stratum (15 per cent cover). Rubus pubescens, Equisetum sylvaticum and Cornus canadensis, all with three per cent cover, are the dominants. Calamagrostis canadensis and Lycopodium annotinum (stiff club-moss) both have two per cent cover. Other notable species present in small quantities include Gymnocarpium dryopteris (oak fern) and Coptis trifolia (goldthread). A variety of other species common to the mesic Populus tremuloides forests are present but generally have low cover values.

The moss carpet is patchy and discontinuous with 30 per cent cover. Pleurozium schreberi (20 per cent cover) is dominant, with the other two common feathermosses contributing most of the remaining bryoid cover.

While most Betula papyrifera stands are quite mesic, with Abies balsamea in their understory, some drier Betula papyrifera - Populus tremuloides groves were noted east of Crow Lake. They tend to be open stands, with a strong herbaceous and graminoid understory development.

7.2.3 Mixedwood Forest Unit

Pinus banksiana - Populus tremuloides / Picea glauca / Vaccinium vitis-idaea / Pleurozium schreberi Community Type 1 (Jack Pine - Aspen / White Spruce / Bog Cranberry / Feathermoss).

This community type is found on submesic to mesic, well-drained sandy substrates. It is usually developed on moderately steep (10-13 per cent) southerly slopes, although it does occur less frequently on more gentle north-facing slopes.

This community type covers about three per cent of the study area (Tables 3 and 5), and appears to be most common in association with *Pinus banksiana* stands on sandy ridges throughout the upland organic-moraine complex (Terrain System I - Figure 13) (Figures 17 and 19). Several soil pits were dug in this community type and Brunisolic Gray Luvisols are present in the stands occurring within the Crow Lake basin. Eluviated Eutric Brunisols are common under this community type throughout the rest of the study area.

This type is variable, but characterized by a canopy of *Pinus banksiana* (average of 28 per cent, range 15-40 per cent cover) and *Populus tremuloides* (average of 16 per cent, range 3-17 per cent cover). Total tree canopy cover ranges from 30-64 per cent. This community type develops following a moderately intense fire, after which both *P. tremuloides* and *Pinus banksiana* regenerate together. The trees are 50-80 years old with a canopy height of 15-20 m (Table 6). Deadfall is light (4 per cent average cover).

A second tree canopy of successional *Picea glauca* is present at 12-15 m height; cover is 4-18 per cent (average of 12 per cent). Although all the stands surveyed had this secondary canopy species, *P. mariana* replaces *P. glauca* on more mesic sites.

The tall shrub layer is sparse (five per cent average cover), with *P. glauca* dominant. Two *Salix* species, *S. bebbiana* and *S. scouleriana*, are present in one of the stands. All the surveyed communitees had *Populus tremuloides* in the low shrub stratum (two per cent average cover).

Cover in the herb-dwarf shrub layer is variable (range 18-65 per cent, average of 43 per cent). In all the stands, *Vaccinium vitis-idaea* is the major species (17 per cent average cover) with *V. myrtilloides* (eight per cent average cover), *Cornus canadensis* (seven per cent average cover) and *Linnaea borealis* (six per cent average cover) as other prominents. *Ledum groenlandicum*, *Maianthemum canadense*, *Rosa acicularis*, *Vibernum edule*, *Elymus innovatus*, *Geocaulon lividum* (bastard toad-flax), *Lycopodium annotinum* and *L. complanatum* are present in low amounts. Species of more mesic habitats, such as *Trientalis borealis* and *Equisetum* spp. are found in the more closed stands (e.g., stand 45, Appendix II).

The bryoid cover is variable, ranging from 30 per cent in open, drier stands to 70 per cent in more closed, moister habitats. In all

cases Pleurozium schreberi is the dominant moss, with a cover of around 30 per cent. Also important is Hylocomium splendens with nine per cent average cover, and Dicranum polysetum or D. undulatum with five per cent to six per cent combined covers. The cover of Cladina mitis varies, ranging from 0.5 per cent to 15 per cent.

Populus tremuloides - Picea glauca / Abies balsamea / Vibernum edule / Cornus canadensis - Herb Community Type 2 (Aspen - White Spruce / Balsam Fir / Low-bush Cranberry / Bunchberry - Herb).

Populus tremuloides - Picea glauca mixedwood is present throughout the study area as a successional intermediate between young Populus tremuloides stands (Deciduous Forest Type 1, Table 5) and mature Picea glauca forest (Coniferous Forest Type 1, Table 5). Covering a substantial area within the study area (13 per cent) (Table 3), it is most widespread in the undulating terrain surrounding Crow Lake (Terrain System II and northern part of III - Figure 13) (Figures 17 and 19). Sites are mesic, and moderately well-drained. The stands are found on middle to upper gentle slopes on all aspects. Deadfall is usually moderate (eight per cent average cover), but can be much higher in older decadent stands.

Numerous soil pits were dug in these mixedwood stands. Eluviated Dystric Brunisols are quite common on the sandier substrates. Brunisolic Gray Luvisols are equally abundant on the more fine-textured materials.

These mixedwoods often have well-developed canopies, usually with large mature trees. Populus tremuloides is the dominant tree in most cases (average of 30 per cent, range 18-48 per cent cover); Picea glauca contributes an average of 17 per cent cover (range 5-30 per cent). Both species are similar-sized with the coniferous trees 28-33 m tall (at least 90 years old, 29-59 cm dbh). The Populus tremuloides tend to be 28-31 m tall (80+ years old, 34-44 cm dbh) (Table 6). Canopy cover is moderate, with an average cover of 50 per cent. Occasionally, small amounts of Populus balsamifera or Abies balsamea are present in the upper canopy.

Picea glauca (nine per cent average cover) and Abies balsamea (two per cent average cover) are the main components of the open second tree layer, which averages 15-20 m in height. Betula papyrifera is usually present, but in amounts of two per cent cover or less.

Most of these stands are characterized by a substantial Abies component in the understory. A. balsamea is dominant in the tall shrub layer, with an average height of three metres. Locally, it can form quite dense thickets, although the average cover is only 10 per cent. Alnus crispa is present in the more open stands, with up to five per cent cover. Abies balsamea is the dominant low shrub layer species (nine per cent average cover). Other species contribute minor amounts to give an overall average cover of 13 per cent.

Cover in the herb-dwarf shrub stratum varies from 30-70 per cent (average of 56 per cent), and is influenced by the relative

amounts of deciduous and coniferous cover in the overstory. In all the stands, the following dominants are present: Vibernum edule (nine per cent average cover), Rosa acicularis (eight per cent average cover), Aralia nudicaulis (six per cent average cover), Mertensia paniculata (four per cent average cover), Petasites palmatus (three per cent average cover), Cornus canadensis (eight per cent average cover), Linnaea borealis (seven per cent average cover) and Mitella nuda (bishop's-cap) (four per cent average cover). The first four species are more prominent in open stands, and the last three more prominent in more closed stands.

In shadier locations where more Picea glauca and Abies balsamea are present, species such as Dryopteris spinulosa, Equisetum sylvaticum, Monesis uniflora (one-flowered wintergreen), Lycopodium annotinum, Pyrola secunda (one-sided wintergreen) and Viola spp. (violet) are present. Actaea rubra, Calamagrostis canadensis, Epilobium angustifolium, Lathyrus ochroleucus, Rubus pubescens, R. strigosus and Vicia americana are characteristic of the more open sites (all with average covers of from one per cent to three per cent).

Maianthemum canadense, Fragaria virginiana (wild strawberry), Galium boreale and Trientalis borealis are present in all stands, but with low cover values.

Abies balsamea regeneration under 0.5 m tall ranges from 0.1 per cent to 15 per cent cover, with the highest cover occurring in the Picea glauca-dominated forests.

From 22 to 34 species are present in the herb-dwarf shrub layer, which is comparable to mesic Populus tremuloides stands. Species richness is high because of the variety in microhabitats present under the mosaic of P. tremuloides, Picea glauca and Abies balsamea trees.

Bryoid cover ranges between 8-65 per cent (average of 27 per cent). Hylocomium splendens is dominant (12 per cent average cover) reaching a high of 35 per cent cover in the denser coniferous-dominated woods, absent in drier sites. Pleurozium schreberi varies from 0.2 per cent to 10 per cent cover (average of seven per cent) and Ptilium crista-castrensis averages four per cent cover (range 0.1-15 per cent). A number of other bryophyte and lichen species are present but with low cover values.

Populus tremuloides - Picea glauca forests growing on moderate south- or west-facing slopes tend to be more sparse in understory species (especially with the taller herbs and shrubs) than the more mesic stands described above. Generally, the species composition is similar to that in the more mesic sites but these drier sites have a greater cover of species such as Elymus innovatus.

Because this community type is most often found on undulating morainal and glaciofluvial material, these closed forests are often interspersed by kettle-like depressions. In the larger kettles are patches of Picea mariana - feathermoss forest or peatland transition

stands (Coniferous Forest Types 5 and 6, respectively - Table 5). The smaller, shallower ones are usually vegetated by herbaceous species. In one of the wet openings south of Crow Lake, Calamagrostis canadensis, Carex rostrata (beaked sedge) and Potentilla palustris (marsh cinquefoil) were the sole dominants in the herb layer. Sphagnum angustifolium and Calliergon stramineum dominated an extensive bryoid cover.

These depressions are especially common in the extensive mixedwood forests on the upland glaciofluvial complex (Terrain System III - Figure 13) south of Crow Lake. Reconnaissance of these mesic woods showed there were many wet openings, often 20 m to 30 m across, dominated by Calamagrostis spp. (reed grass).

7.2.4 Open Slope Unit

Arctostaphylos uva-ursi - Vaccinium myrtilloides - Forb Community Type 1 (Common Bearberry - Blueberry - Forb).

This community type was noted once in the study area, covering an area of two hectares, on a steep (23 per cent), south-facing valley slope east of Crow Lake (stand 38, Figure 15, Appendix 11). As it probably does not occur elsewhere within the study area, it is classed here as a special feature (Figure 20).

This site is characterized by a sparse cover of Populus tremuloides (three per cent) and Pinus banksiana (0.5 per cent) averaging 12 m in height. A denser secondary tree stratum, averaging eight metres in height, is composed of Picea glauca (15 per cent cover) and Betula papyrifera (eight per cent cover). The trees tend to be clumped, with large open spaces between.

With four per cent and two per cent cover respectively, Picea glauca and Salix bebbiana comprise the tall shrub layer. S. bebbiana, with 10 per cent average cover, and Populus tremuloides, six per cent cover, are the major components of the low shrub layer.

Total herb-dwarf shrub cover is 60 per cent. Arctostaphylos uva-ursi (20 per cent cover) and Vaccinium myrtilloides (18 per cent cover) are the dominants. Elymus innovatus with four per cent cover is the major graminoid species. Arnica cordifolia (heart-livered arnica), Aster conspicuous, Campanula rotundifolia, Epilobium angustifolium, Erigeron sp. (fleabane), Fragaria virginiana, Hieracium umbellatum (narrow-leaved hawkweed), Lilium philadelphicum (western wood lily), Oryzopsis pungens (northern rice grass), Potentilla tridentata (three-toothed cinquefoil), Shepherdia canadensis (Canadian buffaloberry) and Symphoricarpos albus (snowberry) are all present but with low cover. Many of these species are not common to most of the study area, and are restricted to the driest sites (Appendix 9). Community sampling was concentrated on the open areas. In the more mesic areas under tree canopy cover, species common to the mixedwood and coniferous forests of the study area are found.

Bryoid cover is four per cent, consisting mainly of Cladina mitis (three per cent cover) in the open areas and Pleurozium schreberi (two per cent cover) under the tree canopy.

This community type is probably slowly changing to closed forest. However, after a fire, intense solar radiation at the ground surface creates warm and dry conditions on this south-facing slope, thus retarding the growth of woody vegetation.

7.2.5 Upland Willow Unit

Salix bebbiana / S. pyrifolia / Calamagrostis canadensis - Herb Comunity Type 1 (Beaked Willow / Balsam Willow / Marsh Reed Grass - Herb).

This plant community is most often found on mesic northerly aspects. It usually forms small thickets within upland forests, most commonly in the Crow Lake basin.

One stand was sampled of this community type (stand 14, Appendix 11). The Salix spp. can be quite robust. S. bebbiana reaches the low tree stratum (eight metres in height), with a cover of 15 per cent; Alnus tenuifolia (river alder) has two per cent cover. The tall shrub layer (two metres to five metres in height) has a fairly dense Salix cover (30 per cent); S. bebbiana (15 per cent cover) and S. pyrifolia (balsam willow) (15 per cent cover) are dominant, followed by S. myrtillifolia (myrtle-leaved willow) (10 per cent cover) and S. arbusculoides (shrubby willow) (three per cent cover).

The herb and dwarf shrub stratum is moderately open (30 per cent cover). It has a distinct grassy appearance due to the seven per cent Calamagrostis canadensis cover. Mertensia paniculata (three per cent cover), and Ribes glandulosa (skunk currant), R. hudsonianum (wild black currant), Mitella nuda and Rubus strigosus (all with two per cent cover) are other noteworthy species. Twenty-six species comprise this layer.

The bryoid stratum is sparse. A number of species characteristic of moist eutrophic upland sites are present, with a total cover of one per cent.

This type of mesic upland Salix community has been noted on other north-facing slopes around Crow Lake. Upland Salix thickets on south-facing slopes tend to be more open with a more dense herbaceous understory.

7.3 Wetland Vegetation

Based on the plant community surveys, the wetland vegetation has been classified into 12 community types, within five units (Table 7). The basis for the wetland plant community classification follows that used by Jeglum et al. (1971) and Rubec and Pollet (1979) in which both physiognomy and composition are used. Table 8 outlines the criteria used to classify the wetland communities within the study area.

There are two community types which represent the Open Treed Peatland Unit (Table 7). Two low shrub fen types, one Carex fen type and one pattern fen type comprise the Poor Fen Unit. The Marsh Unit consists of a shore marsh and a stream marsh community type. One community type is identified in the Wet Meadow Unit. The Swamp Unit combines a floodplain Salix type, a shoreline Alnus type and a streamside Alnus type. Two types of miscellaneous wetland communities are also described.

7.3.1 Open Treed Peatland Unit

Picea mariana / Ledum groenlandicum / Sphagnum fuscum - S. angustifolium Community Type 1 (Black Spruce / Common Labrador Tea / Sphagnum).

Picea mariana open treed peatlands form extensive pure stands in broad, level to shallow depressional situations (Figures 17 and 18). Soil moisture is subhygric to hygric, imperfectly- to poorly-drained. Open water ranges from 0 per cent to 5 per cent cover. This community type is often found in a band between the upland forests and the very wet, open poor fen communities (Table 4). It is most widespread in the far northern, eastern and southeastern portions of the study area (Figure 19) and is the major vegetation type throughout most of the organic-morainal upland complex (Terrain System I, Figure 13). It covers approximately 14 per cent of the study area (Table 7).

Depth of the underlying organic mat is unknown for these sites, but in all four pits sampled, it exceeded 1.5 m depth, thus putting the soils within the Organic soil order. Actual depths of organic matter can be interpolated from surface contours of adjacent upland landforms. In all probability, except for the drier margins where Gleysols may be present, the soils underlying these open treed peatlands are organics. Most of the soils appear to be Fibrisols (Appendix 8.4). Depth to the water table varies from 0.1 m to 0.5 m, and fluctuates seasonally. In some pits, a mesic layer below 60 cm was noted. Numerous charcoal bands suggest that fires frequently sweep through the area.

Table 7

WETLAND PLANT COMMUNITY TYPES OF THE CROW LAKE STUDY AREA[1,2,3]

	Stand Numbers of Surveyed Communities	Corresponding Phase 3 Forest Inventory Units		Percentage of Study Area Covered
7.3 Wetland Vegetation				
7.3.1 Open Treed Peatland Unit				
1) *Picea mariana / Ledum groenlandicum / Sphagnum fuscum - S. angustifolium*	1, 21, 46, 51, 55, 2	Coniferous Scrub	↑	13.9
2) *Larix laricina / Betula pumila / Smilacina trifolia - Carex spp. / Sphagnum angustifolium*	68	Treed Muskeg	↕	< 0.5
				Total 14.4
7.3.2 Poor Fen Unit				
Low Shrub Fen				
1) *Chamaedaphne calyculata - Betula pumila / Sphagnum angustifolium - S. magellanicum*	36, 22, 20, 56, 64	Treed Muskeg and Open Muskeg	↕ ↓	4.0
2) *Salix pedicellaris - Chamaedaphne calyculata / Scheuchzeria palustris / Sphagnum majus - S. jensenii*	19, 29, 60, 57	Open Muskeg	↓	2.2
Sedge Fen				
1) *Carex aquatilis - C. limosa / Sphagnum majus*	17	Open Muskeg	↓	2.3
Patterned Fen				
(String) *Andromeda polifolia - Chamaedaphne calyculata / Sphagnum angustifolium - S. magellanicum*	one community described	Open Muskeg	↓	0.8
(Flark) *Carex limosa - C. chordorrhiza / Sphagnum jensenii - S. majus*				
				Total 9.3

7.3.3 Marsh Unit				
Shore Marsh				
1) Carex aquatilis - C. rostrata / Drepanocladus aduncus	69, 76, 7	Open Muskeg	+	< 0.2
Stream Marsh				
1) Calamagrostis canadensis - Carex aquatilis / Drepanocladus aduncus	71	Open Muskeg	+	< 0.1
				Total 0.3
7.3.4 Wet Meadow Unit				
1) Calamagrostis canadensis - Petasites sagittatus - herb	73	no units		< 0.1
				Total 0.1
7.3.5 Swamp Unit				
Floodplain Willow Swamp				
1) Salix planifolia / Calamagrostis canadensis - Carex aquatilis	13, 40, 74, 59	Deciduous Scrub	ᔓ	1.0
Shoreline Alder Swamp				
1) Alnus tenuifolia - Salix planifolia / Calamagrostis canadensis - Carex aquatilis - herb	9, 75	Deciduous Scrub	ᔓ	< 0.5
Streamside Alder Swamp				
1) Alnus tenuifolia / Calamagrostis canadensis - Caltha palustris	3, 41	Deciduous Scrub	ᔓ	< 0.1
				Total 1.6
7.3.6 Miscellaneous Wetland Habitats				
1) Boggy Depressions and Streamside Communities in Picea mariana - feathermoss forests	66, and other sites described	no units		< 0.5

2) Beaver Ponds and Dams	.	several sites described	flooded land	0.2
				Total 0.7
				Grand Total 26.4

NOTE: [1] "Wetland" refers to site moisture status, subhygric to hygric.
[2] The numbering system of the wetland plant communities in this table corresponds to the numbering system in the text.
[3] The Phase 3 Forest Inventory system uses "Muskeg" in their classification, this term is equivalent to "peatland" in the text.

Table 8

WETLANDS CLASSIFICATION FOR CROW LAKE STUDY AREA

1. Open Treed Peatland Unit (7) : Stands with a tree stratum of *Picea mariana* or *Larix laricina*, an ericaceous shrub layer (usually *Ledum groenlandicum*), and underlain by a relatively continuous horizon of firmly consolidated *Sphagnum* peat, with occasional feathermoss areas. Weakly minerotrophic. Little or no standing water.

   1.1 Treed *Picea mariana* Peatland (6).
   1.2 Open *Larix laricina* - *Picea mariana* Peatland (1).

2. Poor Fen Unit (11) : Open stands, with a varying mixture of ericaceous shrubs and graminoid species. Underlain by a continuous layer of *Sphagnum* spp. Weakly minerotrophic, as shown by indicator species (e.g., *Betula pumila*).

   2.1 Low Shrub Fen (9) : Characterized by a varying cover of ericaceous and/or *Salix* shrubs, less than 1 m in height.
      2.1.1 Hummocky (5) : *Sphagnum* dominant, characterized by combinations of *S. angustifolium*, *S. magellanicum* and *S. fuscum*. Relatively drier.
      2.1.2 Low Hummocks to Flat (4) : *Sphagnum majus* and *S. jensenii* dominant. Greater cover of graminoid species, more standing water.
   2.2 Sedge Fen (1) : No shrubs, adjacent to water bodies, much standing water.
   2.3 Patterned Fen (1) : Characterized by alternating pattern of elongated hummocks (strings) and depressions (flarks).

3. Marsh Unit (4) : Zone of emergent vegetation composed of sedges, grasses and rushes, adjacent to water bodies. Small emergent and submergent species below the canopy. Often associated with brown mosses, mesotrophic to eutrophic.

   3.1 Shore Marsh (3).
   3.2 Stream Marsh (1).

4. Wet Meadow Unit (1) : Graminoid meadows, seasonally wet, usually on low stream terraces. Associated with a rich herbaceous flora. Eutrophic.

5. Swamp Unit (9) : Wooded, non-boggy wetlands, flat or hummocky surface. Usually has greater than 25% shrub cover, greater than 1 m tall. Eutrophic to mesotrophic.

   5.1 Floodplain *Salix* Swamp (4).
   5.2 *Alnus*-dominated Streamside Swamp (2).
   5.3 *Alnus*-dominated Shoreline Community (2).

6. Miscellaneous Wetland Habitats.

   6.1 Boggy depressions and streamside communities in *Picea mariana* - feathermoss forests.
   6.2 Beaver ponds and dams.

NOTE: Bracketed numbers are the number of stands surveyed in that particular community type.

Picea mariana assumes a slow growing, stunted form in these habitats. Trees of all ages are present, and maximum height rarely exceeds nine metres (Table 6). It forms a ragged, irregular, sparse canopy (eight per cent average cover) at a height of six to eight metres. Uneven-sized P. mariana are also the sole constituents of the tall and low shrub strata (23 per cent and eight per cent average cover respectively). Cover values in these strata are quite uniform (ranges 18-25 per cent and 5-20 per cent respectively).

The herb-dwarf shrub layer is moderately dense (46 per cent average cover) and composed of a depauperate ombrotrophic flora dominated by ericaceous shrubs (Table 8). Ledum groenlandicum is dominant (23 per cent average cover), Vaccinium vitis-idaea (nine per cent average cover), Rubus chamaemorus (13 per cent average cover) and Chamaedaphne calyculata (leather-leaf) (five per cent average cover) are common. Young Picea mariana under 0.5 m height add an average of seven per cent cover to this stratum. Smilacina trifolia and Oxycoccus microcarpus (small bog cranberry) occur, but with low cover values. In some sites, species such as Betula pumila, Carex aquatilis (water sedge), Equisetum spp., Pedicularis labradorica (Labrador lousewort) and Salix myrtillifolia are found. These species indicate weakly minerotrophic conditions (Sjörs 1963, Jeglum 1971).

Due to the cool, wet, acidic conditions in this habitat, decomposition of organic matter is retarded and peat accumulation has occurred. There is an almost continuous bryoid stratum (95 per cent average cover). The microtopography is hummocky and results in a mosaic of Sphagnum spp., feathermosses and lichens, the relative proportion of each varying from site to site. S. fuscum, which grows on the drier hummocks, is generally dominant (31 per cent average cover) although it is quite variable in cover (0-75 per cent range).

S. magellanicum (eight per cent average cover) is found on the sides of large hummocks and the tops of smaller ones. S. angustifolium (28 per cent average cover) is a species of shadier, wetter habitats and is found in the inter-hummock depressions. Although the vascular flora indicate ombrotrophic conditions, S. angustifolium is representative of a weakly minerotrophic nutrient status and so this community cannot be classified as a true bog in the strict sense (Horton et al. 1979). Pleurozium schreberi is present in varying amounts (range 0.5-30 per cent, 17 per cent average cover) and is most frequent in mesic microhabitats in the drier peatlands. A wide variety of Cladonia spp. is present in small amounts on the drier hummocks. Due to the diverse microhabitats on the hummocky peatland surface, bryoid richness is high, reaching 19 species in stand 46 (Appendix 11).

In general, the Picea mariana peatlands occurring throughout the study area are quite similar in structure and floristics. However, there is a gradient from dry to wet sites. Drier stands have more Vaccinium vitis-idaea, Ledum groenlandicum, Pleurozium schreberi and lichens, while wetter ones have more Chamaedaphne calyculata, Eriophorum spp. (cotton grass), Carex spp., Smilacina trifolia, Rubus chamaemorous and Sphagnum spp. The actual species composition and cover in any one stand depends on the ratio of hummocks to hollow areas.

Sometimes this treed peatland type is interspersed with small pockets of wetter open vegetation, such as in the southwest corner of the study area. One of these wetter areas was sampled. This hygric site is poorly-drained and is in a shallow depression with five per cent cover of standing water. It is moderately minerotrophic and is dominated by Betula pumila (30 per cent cover) with lesser amounts of Salix myrtillifolia (10 per cent cover). This shrubby layer is around 0.5 m tall. Carex aquatilis, Smilacina trifolia, Salix pedicellaris (glaucous bog willow), Andromeda polifolia (bog rosemary) and stunted Larix laricina are present in small amounts.

Sphagnum warnstorfii (40 per cent cover) and Sphagnum angustifolium (30 per cent cover) are the dominant bryophytes with lesser amounts of Aulacomnium palustre and Drepanocladus lapponicus (five per cent cover each) combining to give a bryoid cover of 92 per cent.

In the wettest parts of this depression, open water covers about 15 per cent of the area and Carex aquatilis and Drepanocladus spp. become dominant with some Potentilla palustris and Caltha palustris (marsh marigold) as well.

Larix laricina / Betula pumila / Smilacina trifolia - Carex spp. / Sphagnum angustifolium Community Type 2 (Tamarack / Swamp Birch / Three-leaved Solomon's-seal - Sedge / Sphagnum).

This community type is not common in the Crow Lake study area, and probably covers less than 0.5 per cent of the area. It is physiognomically similar to the Picea mariana peatland described above but tends to be wetter (subhydric) and is more eutrophic. Moss (1953, 1955) describes a similar community type as "tamarack swamp" although the one stand surveyed in this report is too open to be classified as a swamp (Table 8).

This peatland community type is best developed in small depressions or on the edges of larger ones. Minerotrophic groundwater from the surrounding uplands provides nutrients which allow a more minerotrophic flora to become established as compared to the treed P. mariana peatland.

Larix laricina and Picea mariana are present as a sparse tall shrub stratum about 3.5 m tall (four per cent and one per cent cover respectively). These same two species also form the low shrub stratum with seven per cent Larix laricina and five per cent Picea mariana cover.

The herb-dwarf shrub layer is dominated by Betula pumila (20 per cent cover), Salix planifolia (flat-leaved willow) (10 per cent cover), Oxycoccus microcarpus (six per cent cover) and Chamaedaphne calyculata (five per cent cover). Smilacina trifolia (seven per cent cover) is the major herb. Species such as Carex aquatilis five per cent cover), C. limosa (mud sedge) (three per cent cover) as well as C. chordorrhiza (prostrate sedge), C. canescens, and C. rostrata, Equisetum fluviatile (swamp horsetail), Habenaria hyperborea (northern

green orchid), Potentilla palustris and Salix spp. are indicative of the richer nutrient status of this stand as compared to the Picea mariana peatland (Jeglum 1971). The species richness of 22 is higher than in P. mariana peatlands.

The bryoid cover is 95 per cent. Sphagnum angustifolium (55 per cent cover) is dominant in the wetter microhabitats. S. magellanicum (20 per cent cover) and S. fuscum (10 per cent cover) are found on the wetter and drier hummocks respectively. Smaller amounts of the minerotrophic mosses Aulacomnium palustre and Drepanocladus fluitans are also present.

Within this community type there is a wetter area which forms a floating mat bordering a small pond. The major species are Eriophorum viridi-carinatum (thin-leaved cotton-grass), Carex limosa, C. aquatilis, Potentilla palustris and Menyanthes trifoliata (buck-bean). Drepanocladus aduncus and Sphagnum riparium form a loose bryoid mat.

Several other stands have been visited which are similar to the open Larix laricina - Picea mariana community described above. Many of the dominants are the same; however, new species such as Carex diandra (two-stamened sedge), Salix serissima (autumn willow), and the mosses Sphagnum warnstorfii and S. teres were noted.

7.3.2 Poor Fen Unit

Low Shrub Fen

Within the Crow Lake study area low shrub fens are of two kinds (Table 8). The first type is more hummocky with a varying cover of ericaceous dwarf shrubs (less than 0.5 m tall) and a low component of graminoid species. Sphagnum angustifolium, S. magellanicum and S. fuscum are the dominant bryoid species.

The second faciation is wetter, less hummocky, and dominated by Sphagnum majus and/or S. jensenii. While the shrub cover can be as dense as in the first community type, the graminoid cover is much more prominent.

Chamaedaphne calyculata - Betula pumila / Sphagnum angustifolium - S. magellanicum Community Type 1 (Leather-leaf - Swamp Birch / Sphagnum).

This community type is developed in hygric to subhydric situations in wetter parts of broad upland depressions in Terrain System I (Figure 13). It is most extensive in the east and east-central portions of the study area near some of the large shallow ponds southeast of Crow Lake (Figures 17, 18 and 19). A few small stands occur along the northern boundary of the study area.

Although soils data was not collected, this community type is probably underlain by Fibrisols.

This community grades into the drier, open treed peatland (Coniferous Forest Type 5 - Table 5) on the upland side (Table 4) and is transitional to the wetter, less hummocky, shrubby poor fen on the downslope gradient. It covers approximately four per cent of the study area (Table 7).

This open community has an irregularly hummocky surface (0.2-0.4 m microrelief), with distinct plant associations corresponding to the drier and wetter microhabitats. The hummocks comprise around 60-65 per cent of the surface, and standing water is only 0-15 per cent in cover, thus the hummock species, primarily ericaceous shrubs, dominate the community.

The vegetation is mostly less than 0.5 m tall. Scattered individuals of Betula pumila, Larix laricina and Picea mariana reach the low shrub layer (height 0.5-2 m) where cover ranges from 0.2-4 per cent (average of one per cent).

The cover of the dominant species on the hummocks varies between stands. Chamaedaphne calyculata (average of 15 per cent, range 5-35 per cent cover), Betula pumila (average of 11 per cent, range 0-40 per cent cover) and Andromeda polifolia (10 per cent, range 0-25 per cent cover) are the main species. Oxycoccus microcarpus, Salix pedicellaris, Kalmia polifolia (mountain laurel) and Rubus chamaemorus are also usually present on the hummocks.

In the inter-hummock depressions, Scheuchzeria palustris (three per cent average cover), Carex rostrata (one per cent average cover) and C. limosa (one per cent average cover) are the dominant graminoids. In wetter sites C. vesicaria (blister sedge) is present with up to 15 per cent cover. This community type has an average total shrub cover of 46 per cent (range 22-79 per cent) and an average total graminoid cover of 7.5 per cent (range 1.5-18 per cent). The total herb-dwarf shrub cover is moderate at 34 per cent (range 28-50 per cent).

The hummock-hollow microtopography is clothed in a nearly continuous (average of 95 per cent) cover of Sphagnum angustifolium (43 per cent average cover), S. magellanicum (29 per cent average cover) and S. fuscum (18 per cent average cover). Aulacomnium palustre, Pohlia nutans and Polytrichum strictum grow on the hummock tops in small amounts.

Many of the sedges and a few of the shrubs are indicative of a mineratrophically weak nutrient status (Jeglum 1971) which is why this community type is classified as a poor fen.

Salix pedicellaris - Chamaedaphne calyculata / Scheuchzeria palustris / Sphagnum majus - S. jensenii Community Type 2 (Glaucous Bog Willow - Leather-leaf / Scheuchzeria / Sphagnum).

This open community type is quite similar to the shrubby poor fen community described above. Although found in the same general location (Figures 17, 18 and 19), this community tends to occur in slightly wetter conditions (subhydric, poorly- to very poorly-drained) and is often closer to open water bodies. As well, the microtopography is less hummocky (average microrelief is 0.2 m). Hummocks comprise 40-50 per cent of the surface, and standing water from zero to 10 per cent. Water conditions can fluctuate drastically: one site visited in May was dry, while in late July after a few weeks of rain was 80 per cent water-covered. Because of lower and fewer hummocks in this community type, as compared to the first shrubby poor fen type described, many of the species are adapted to these fluctuating water levels.

This community type covers approximately two per cent of the study area (Table 7).

There is little vegetation taller than the herb-dwarf shrub layer. Dominant dwarf shrub species are Salix pedicellaris (eight per cent average cover), Chamaedaphne calyculata (seven per cent average cover) and Andromeda polifolia (two per cent average cover). Although absent from most stands, Betula pumila can locally attain 15 per cent cover. B. papyrifera, Kalmia polifolia and Oxycoccus microcarpus are sometimes present in low amounts.

This stand type has a combined ericaceous species cover which is lower than that of the drier shrub fen type (average of 23.5 per cent, range 12-42 per cent cover). Graminoid species tend to exhibit high cover because of the greater amount of wet inter-hummock depressions; total average cover is 18 per cent, range is 12-42 per cent. Scheuchzeria palustris is dominant with an average cover of seven per cent, followed by Carex limosa (four per cent average cover), C. vesicaria (two per cent average cover) and Eriophorum viridi-carinatum (two per cent average cover). Potentilla palustris and Menyanthes trifoliata are occasionally present. This community type is formed on poorly minerotrophic substrates, although in some of the wetter areas, mesophytic conditions exist as shown by the presence of such indicator species as small Utricularia minor (bladderwort) (Jeglum 1971).

These open wet substrates are usually dominated in the bryoid layer by either Sphagnum majus (two stands, 70 per cent average cover) or S. jensenii (one stand, 85 per cent cover) (Appendix 11). In a fourth stand sampled, the three hummock-hollow sphagna, S. angustifolium, S. fuscum and S. magellanicum, are common. This stand is more hummocky and transitional to the drier fen type. Sphagnum fuscum and S. magellanicum have a combined cover of 21 per cent in the three wetter stands, where they occupy the low hummocks. Total bryoid cover of this community averages 92 per cent.

Stand 60 (Appendix 11) has several low concentric-shaped peat mounds near its margin. These are dominated by stunted Picea mariana, and may be ice-cored palsas. They will be discussed more fully in the special features section (Figure 20).

Sedge Fen

Carex aquatilis - C. limosa / Sphagnum majus Community Type 1 (Water Sedge - Mud Sedge / Sphagnum).

Carex fens are restricted to two locations within the study area. The most extensive is in the east-central part along the boundary. Two smaller Carex fens border shallow ponds in the central part of the study area, southeast of Crow Lake (Figures 17, 18 and 19). This community type occupies about two per cent of the study area (Table 7).

These fens range in size from about 30 ha in the central areas to 100 ha on the eastern boundary of the study area, and are very uniform. They are probably underlain by Mesisols or Fibrisols, but the soils were not investigated.

This community type is usually subhydric and very poorly-drained, with a loose mat of Sphagnum lying on the water which surrounds the emergent vegetation. However, the one stand that was sampled (stand 17, Appendix 11) was relatively dry after a long rainless period. Similar communities seen later in the summer were found to be much wetter.

These Carex fens are both floristically and structurally simple. In the stand sampled on the eastern edge of the study area (stand 17, Figure 15), there are only six species in total, none of them woody. The sedges Carex aquatilis (seven per cent cover) and C. limosa (six per cent cover) are co-dominant with lesser amounts of Menyanthes trifoliata (two per cent cover), Eriophorum viridi-carinatum (0.5 per cent cover) and Scheuchzeria palustris (0.2 per cent cover). Sphagnum majus dominates the bryoid layer with 95 per cent cover. Microtopography is slightly mounded.

Carex fens in the central part of the study area are similar to the one described above except that C. rostrata is dominant and C. aquatilis is only locally common.

Eriophorum viridi-carinatum and Scheuchzeria palustris are more common in the slightly drier fen margins while the two sedges form extensive stands in the wetter fen expanse. Carex vesicaria is also present with low cover values.

Sphagnum majus is also the dominant bryophyte in these centrally-located fens, with at least 90 per cent cover. Some S. jensenii is present as well and S. angustifolium occurs near the drier fen margin. These bryoid species are indicative of a poor fen (Jeglum 1971). When investigated, this stand was under 15 cm of water

due to recent heavy rains. There are a few small hummocks in the fen (0.3 m high) which are dominated by Chamaedaphne calyculata.

While the fen expanse is floristically simple, there can be a diversity of wetland species along the fen margin where it borders the open water of an adjacent pond. For example, in one of the fens in the central part of the study area, there is an adjacent open water pond. Along the margin between the fen and pond the following species were noted (excluding the species mentioned above): Scirpus microcarpus (small-fruited bulrush), Carex lasiocarpa (hairy-fruited sedge), Eriophorum angustifolium (tall cotton-grass), Juncus filiformis, Caltha palustris, Sagittaria cuneata (arrowhead) and Utricularia intermedia (flat-leaved bladderwort).

Patterned Fen

Andromedia polifolia - Chamaedaphne calyculata / Sphagnum angustifolium - S. magellanicum [String] (Bog Rosemary - Leather-leaf / Sphagnum) Carex limosa - C. chordorrhiza / Sphagnum jensenii - S. majus [Flark] Community Type 1 (Mud Sedge - Prostrate Sedge / Sphagnum).

One patterned fen is located within the study area. It is about 100 ha in extent covering 0.8 per cent of the study area, and lies in the extreme southeast corner of the study area (Figure 19). The fen is near the height of land that divides the Crow Lake watershed (flow northwest) from another unnamed watershed (flow southeast) (Figure 12).

Although this site was not sampled using the stand relevé method, descriptive notes were taken.

The patterning of this poor fen is not well-developed, although some patterning is evident even from 1:50 000 air photos. Groundwater flow is northwest to southeast and the strings are subparallel, running perpendicular to this flow. Some strings look like elongated hummocks, while others form hummocky nodulated, discontinuous strings. They are 0.4 to 0.5 m tall, 0.5 to one metre wide and vary in length from two to 10 metres. Flarks are several metres wide. There is no standing water in the flarks, rather a floating "soupy" vegetal mat.

Because the strings are low and poorly-developed, species such as Picea mariana, Larix laricina or Ledum groenlandicum have not established on them. Instead, they are covered with an open layer of dwarf shrubs: Andromeda polifolia, Chamaedaphne calyculata, Betula pumila and Kalmia polifolia (the first two being dominant). Sphagnum magellanicum and S. angustifolium cover 99 per cent of the string surface, with minor amounts of Pohlia nutans and Aulacomnium palustre on the drier, taller hummocks.

The flarks are also species poor, dominated by an open layer of sedges (Carex limosa and C. chordorrhiza). Eriophorum angustifolium, Menyanthes trifoliata, Scheuchzeria palustris and Andromeda polifolia are present in smaller amounts. Bryoid cover is 100 per cent and formed by an admixture of Sphagnum jensenii and S. majus. In the

wetter flarks the latter species is present along with Drepanocladus exannulatus. Water underlying the flarks in this poor fen has a pH of between 4.7 and 5.0 (three replicates).

Vitt et al. (1975) describe a patterned fen in the Swan Hills of north-central Alberta which is very similar to the patterned fen at Crow Lake. The strings at the Swan Hills site are better developed than those at Crow Lake, and so are vegetated by Picea mariana.

Because this community is the only patterned fen in the study area, it has been noted on Figure 20 as a special feature. It is not well-developed, and there are better examples within 10 miles of the study area to the east and south. This feature is not important in a regional context (Peter Achuff 1983 pers. comm.).

7.3.3 Marsh Unit

Shore Marsh

Carex aquatilis - C. rostrata / Drepanocladus aduncus Community Type 1 (Water Sedge - Beaked Sedge / Drepanocladus).

Site requirements for shore marsh development include well-defined shorelines, which allow the development of relatively deep-water emergent vegetation (Rubec and Pollet 1979). Within the study area, well defined shorelines only occur around the margins of the larger water bodies in the Crow Lake basin (Terrain Systems II and IV - Figure 13). Because of the lack of suitable sites, shore marshes are restricted in the Crow Lake area, covering less than 0.2 per cent of the study area (Table 7).

The most extensive shore marsh community is over 100 m wide and is situated on the north end of "Little Crow Lake". Because it is the only major shore marsh in the study area, it is considered to be a special feature (Figure 20). Smaller shore marshes, usually only 20 m wide, are found along a small lake east of Crow Lake, and to a limited extent, along the southern outlet to Crow Lake.

Marshes were sampled on all the three above-mentioned waterbodies (stands 69, 76 and 7, Table 15, Appendix II). They are emergent by definition (Table 8) and so have a hydric moisture status.

Two of the three sampled stands are fairly deep marshes, with water levels ranging between 0.5-0.6 m. They are floristically simple, dominated by the sedges Carex aquatilis (48 per cent average cover) and C. rostrata (23 per cent average cover) which reach 1.5 m to two metres in height from the rooting zone. Glyceria borealis (manna grass), Typha latifolia, Carex prairea (prairie sedge) and Calamagrostis inexpansa (northern reed grass) are the other common graminoids. Calla palustris (water arum), Cicuta douglasii (water hemlock), Galium trifidum (small bedstraw), Petasites sagittatus (arrow-leaved coltsfoot) and Sium suave (water parsnip) are often present but with

low cover values. Lemna minor (common duckweed) (10 per cent average cover) and Utricularia minor are always found on the water. Herbaceous cover averages 75 per cent.

Bryoid cover averages 30 per cent. Although observed at only one site, Drepanocladus aduncus is probably quite common, growing in the water among the culms. Campylium radicale is another major species.

A third site surveyed was in a shallow shore marsh on Crow Lake. The dominant Carex spp. are similar to the other two sites, but because of shallower water (30 cm average), there are many more species in this stand. These include Calamagrostis canadensis (30 per cent cover), Mentha arvensis (wild mint) (10 per cent cover), Urtica gracilis (common nettle) (eight per cent cover), Geum macrophyllum (yellow avens) (four per cent cover), Scirpus microcarpus (four per cent cover) and Scutellaria galericulata (common skullcap) (two per cent cover). Bryoid cover is light, averaging one per cent.

Other Semi-Aquatic and Aquatic Lakeshore Vegetation

Although not systematically surveyed, notes were made on the lakeshore vegetation throughout the study area. Along most well-defined waterbodies there is a narrow, discontinuous band, five metres to 10 m wide, of vegetation which is zonally arranged from terrestrial willows to submerged aquatics.

The willows Salix pyrifolia and S. planifolia commonly form lakeshore thickets, along with Alnus tenuifolia. Chrysosplenium iowense (golden saxifrage), Cardamine pensylvanica (bitter cress), Calamagrostis canadensis, C. inexpansa, Urtica gracilis, Sium suave, Geum macrophyllum, Stellaria longifolia (long-leaved chickweed), S. longipes (long-stalked chickweed), Rumex occidentalis (western dock), Potentilla palustris, Cicuta douglasii, Veronica americana (American brooklime), Galium trifidum, G. labradoricum (bedstraw), Epilobium glandulosum (northern willow- herb) and Mentha arvensis are often found along the waters' edge. Eleocharis palustris (creeping spike-rush), Polygonum amphibium (water smartweed), Lysimachia thyrsiflora (tufted loosestrife), Alopecurus aequalis (water foxtail), Agrostis scabra (hairgrass), and the sedges Carex rostrata, C. aquatilis, C. media (Norway sedge) and C. crawfordii (Crawford's sedge) are most frequent in shallow water. In slightly deeper water are Calla palustris, Scirpus microcarpus, Carex prairea, Glyceria grandis (tall manna grass) and Lemna minor.

Equisetum fluvatile and Sagittaria cuneata are often on the outer margin of the emergent shoreline community at 30-50 cm water depth. Typha latifolia is found only in the major marsh communities.

Potamogeton filiformis (inland pondweed) and P. richardsonii (clasping-leaf pondweed) often form extensive aquatic masses in shallow water near the lakeshores along with Ceratophyllum demersum (hornwort) and Myriophyllum exalbescens (spiked water-milfoil) and smaller amounts of Nuphar variegatum (yellow pond-lily).

Stream Marsh

Calamagrostis canadensis - Carex aquatilis / Drepanocladus aduncus Community Type 1 (Marsh Reed Grass - Water Sedge / Drepanocladus).

Streamside marshes are limited in the Crow Lake area covering less than 0.1 per cent of the study area (Table 7). They are found along short stretches of some of the larger creeks that flow into Crow Lake and are best formed where the water level is fairly constant all year, such as upstream from a beaver dam.

Only one community of this type was sampled (stand 71, Appendix 11). It is located east of Crow Lake (Figure 15) and occupies a band about 30 m wide. Water depth is constant throughout the stream marsh, as opposed to the deepening water in shore marshes, and averages 30 cm. Calamagrostis canadensis (35 per cent cover), and the sedges Carex aquatilis (20 per cent cover), and C. prairea (15 per cent cover) are the dominant graminoids, about 1.5 m tall. Carex canescens (seven per cent cover) and Calamagrostis neglecta (narrow reed grass) (five per cent cover) are present as well. The dominant herbs are Polygonum amphibium (three per cent cover), Potentilla palustris (three per cent cover) and Galium trifidum (one per cent cover). Lemna minor is present in small amounts. The marsh edge is bordered by a narrow band of willows composed of Salix planifolia, S. pedicellaris and S. myrtillifolia. This marsh community is quite well-developed with a total herb cover of 60 per cent.

Drepanocladus aduncus was the only bryophyte noted and is estimated to have a cover of 30 per cent. The nutrient status is mesotrophic as is indicated by the species composition (Jeglum 1971) and the water pH reading (5.6 - 2 samples).

Surveys of other stream marshes in the area indicate a similar floristic assemblage. However, several species not mentioned above were noted. They include: Carex rostrata, C. atherodes (awned sedge) and C. diandra, Lysimachia thyrsiflora, Rumex occidentalis and Potentilla palustris.

The deepest stream channel reaches (e.g., Crow Creek, upstream from where it flows into "Little Crow Lake") support an assemblage of aquatic and emergent species which are not always found in shallower water. Sium suave, Glyceria grandis, Sagittaria cuneata, Scirpus microcarpus, Sparganium eurycarpum (giant bur-reed), Myriophyllum exalbescens, Potamogeton richardsonii, Nuphar variegatum, Hippuris vulgaris (mare's-tail) and Lemna minor often grow in the calm, relatively deep stream channel reaches in the study area.

7.3.4 Wet Meadow Unit

Calamagrostis canadensis - Petasites sagittatus - Herb Community Type 1 (Marsh Reed Grass - Arrow-leaved Coltsfoot - Herb).

This community type differs from the stream marsh type in that it is only seasonally flooded and is characterized by a rich herbaceous flora (Table 8). In the Crow Lake study area, only one stand of this community type was found (stand 73, Appendix 11). It is on a low floodplain terrace along Crow Creek, south of Crow Lake, covering several hectares (Figure 15). It has a hydric moisture regime, and is imperfectly-drained with five per cent cover of standing water.

Calamagrostis canadensis is the dominant graminoid with 40 per cent cover followed by Glyceria grandis (10 per cent cover), and the sedges Carex atherodes and C. aquatilis (five per cent cover). These graminoids comprise 45 per cent of the herbaceous cover, and are about 0.5 m to one metre tall. The herbaceous flora is very diverse (25 species) and includes: Petasites sagittatus (15 per cent cover), Urtica gracilis (seven per cent cover), Geum macrophyllum (six per cent cover), Polygonum amphibium (five per cent cover), Senecio pauperculus (balsam groundsel) (four per cent cover) and Delphinium glaucum (three per cent cover). A number of other species including Achillea millefolium (common yarrow), Aster foliaceus (leafy-bracted aster), Epilobium glandulosum and E. palustre (marsh willow-herb) are also present.

The dwarf shrub Rubus acaulis (dwarf raspberry) is present in moderate amounts (five per cent cover). Total herb-dwarf shrub cover is 60 per cent.

The microtopography is hummocky, with tufts of sedges and grasses on drier microhabitats. This is partly responsible for the high species diversity noted here.

Bryoid cover is 50 per cent, dominated by Mnium sp. (30 per cent cover) and lesser amounts of Aulacomnium sp. (15 per cent cover) and Climacium dendroides (5 per cent cover).

7.3.5 Swamp Unit

Floodplain Willow Swamps (Carrs)

Salix planifolia / Calamagrostis canadensis - Carex aquatilis Community Type 1 (Flat-leaved Willow / Marsh Reed Grass - Water Sedge).

Streamside floodplain Salix swamps cover about one per cent of the study area (Table 7), and are most extensive along Crow Creek and several streams near the east end of Crow Lake (Figure 19). These communities are permanently waterlogged, hygric to subhydric, imperfectly- to poorly-drained and occupy the low level floodplain terraces in the wider stream valleys. Microtopography is usually very

hummocky, with microrelief of up to 0.6 m. The hummocks occupy 30-40 per cent of the surface and are formed by an organic buildup around Salix stems. Interhummock depressions are quite wet, with standing water varying from three to 60 per cent cover (average of 21 per cent).

Soil pits were not dug in these sites. It is expected that Mesisols are present in the larger swamps with Gleysols in the smaller ones and along the margins.

The variety in surface relief allows for establishment of a wide variety of species. These communities are species-rich in the herb-dwarf shrub layer (18 to 35 species, average of 27). The dominant species are similar in all four stands surveyed, but the subsidiary flora varies considerably (Appendix 11).

In most cases there is no tree stratum, the only exception being stand 59 (Appendix 11) where Betula papyrifera and Picea mariana form an open stratum (five per cent and two per cent cover respectively) at six metre height. Salix planifolia is the dominant tall shrub, with cover up to 55 per cent at four metre height. Smaller individuals of this Salix species consistently form a low shrub stratum at two metres with an average cover of 13 per cent (range five to 20 per cent). While Salix planifolia is often the only willow species present, in some sites S. pyrifolia and S. myrtillifolia are quite abundant with up to 20 per cent cover in the low shrub layer.

Calamagrostis canadensis (13 per cent average cover), Carex aquatilis (sever per cent average cover) and C. canescens (two per cent cover) are the dominant graminoids and are present in all stands. Carex rostrata, C. diandra and C. limosa are occasionally present. Rubus acaulis (dwarf raspberry), Stellaria longifolia, Viola palustris (marsh violet), Epilobium angustifolium, E. palustre, Galium trifidum, Geum macrophyllum, Petasites sagittatus and Potentilla palustris are often found on hummocks in the understory, but have low cover values. Occasionally, small Salix planifolia, S. myrtillifolia and S. pedicellaris are found in the herb-dwarf shrub layer, with a combined cover value of approximately four per cent. The total cover for this stratum is quite uniform (range 30-45 per cent) and averages 36 per cent.

Due to the diversity of substrates offered by the hummocky microtopography, the bryophyte flora is relatively diverse (eight to 11 species). Most of the species are representative of moist eutrophic habitats. Plagiomnium ellipticum is the most abundant moss (14 per cent average cover) although it is variable in cover (zero to 30 per cent). Aulacomnium palustre, with an average cover of 10 per cent, is present in every sampled stand. Climacium dendroides and Bryum pseudotriquetrum are also common. Drepanocladus exannulatus was noted in only one stand; however, its cover was 65 per cent. It and D. uncinatus are expected in other floodplain Salix swamps, as well, as they are typical of such habitats. Total bryoid cover varies from 45-80 per cent, and is influenced by microtopography.

Some of the Salix swamps are interspersed with herbaceous openings. They are dominated by Carex rostrata and C. aquatilis, Calamagrostis canadensis and other graminoids. Other species such as Valeriana septentrionalis (northern valerian), Senecio pauperculus, Scutellaria galericulata and Ranunculus gmelinii (yellow water crowfoot) are also present. Many of the species found in these openings are also present in the closed Salix swamps.

Shoreline Alder Swamps

Alnus tenuifolia - Salix planifolia / Calamagrostis canadensis - Carex aquatilis - Herb Community Type 1 (River Alder - Flat-leaved Willow / Marsh Reed Grass - Water Sedge - Herb).

These stands are found in limited areas around the major lakes. They occupy a transition zone, about 30 m wide, from dry upland forest to open water. Because of the changing moisture conditions, the substrate ranges from subhygric to hydric and drainage from imperfectly to very poorly-drained. This community type has a strongly mounded microtopography which provides microhabitats for a variety of plant species.

Two sites which represent the extremes within this community type were sampled (stands 9 and 75, Appendix 11). The first is a dense thicket of shrubs and sedges at the east end of Crow Lake. The second is wetter, more open, and is transitional to a shore marsh. It is located on the west shore of "Little Crow Lake" (Figure 15).

Alnus tenuifolia is the dominant tall shrub, averaging four metres in height and having 60 per cent and five per cent cover at the Crow Lake and "Little Crow Lake" sites respectively. (In the following discussion, cover values will be presented in that order.) Salix planifolia forms a canopy at about three metres with covers of 40 per cent and 15 per cent.

The herb-dwarf shrub stratum is fairly dense with 85 per cent and 40 per cent cover noted. The dominant species are Calamagrostis canadensis (40 per cent and nine per cent cover), Carex aquatilis (eight per cent and 12 per cent cover) and C. rostrata (five per cent cover at each site). These have their greatest cover values in the open inter-shrub areas. Potentilla palustris is common in the wetter sites. The Crow Lake community has a number of mesic woodland species [e.g., Ribes spp., Rubus spp. (raspberries)] which are found on the drier hummocks under the dense shrub layer. Because of the ecotonal situation of these sites, both have high species richness (43 and 31 species) in the herb-dwarf shrub layer.

Bryoid cover is moderately high at the "Little Crow Lake" site, with 60 per cent cover. Dominant species include: Plagiomnium ellipticum (30 per cent cover), Brachythecium turgidum (15 per cent cover), Climacium dendroides (five per cent cover) and Drepanocladus uncinatus (five per cent cover). The Crow Lake site has many of the same species but in much lower amounts, with only a three per cent bryoid cover.

The two stands discussed above are the best examples of shoreline swamp seen in the study area. Much of the lakeshores, however, are ringed only with a narrow band of Alnus tenuifolia, approximately five metres wide, the shrubs five to six metres tall. These are not swamp communities, however, as the A. tenuifolia is growing on dry land adjacent to the water.

Streamside Alder Swamps

Alnus tenuifolia / Calamagrostis canadensis - Caltha palustris Community Type 1 (River Alder / Marsh Reed Grass - Marsh Marigold).

Alnus-dominated swamps are present along some of the streams draining the Crow Lake basin, where there is a gentle gradient and some overbank discharge. In some cases the swamp forms a distinct band of wetland vegetation 30 m or so wide, which bisects the forest. In other situations, the forest canopy is uninterrupted and the wetland community development is solely an understory phenomenon.

These stands are subhygric to subhydric, poorly-drained and found on very gentle slopes. In the two stands sampled (stands 3 and 41, Figure 15, Appendix 11), Alnus tenuifolia is the dominant shrub, forming 35-65 per cent cover at a four to six metre height. Minor components of Salix bebbiana and S. discolor are sometimes present. The low shrub layer is usually quite sparse, with only a few smaller Alnus shrubs present.

The cover of the herb-dwarf shrub layer is quite variable, from 15 per cent to 85 per cent. In both cases Calamagrostis canadensis (35 per cent and three per cent) and Caltha palustris (18 per cent and eight per cent) are the dominant species.

In stand 41, the swamp vegetation is intermixed with the surrounding mesic Picea glauca forest so that species of both community types are represented. This results in a high species richness (39 species present). These include a number of forest plants such as Rubus spp. and Ribes spp. as well as Cornus canadensis and Mitella nuda. There are a number of wetland species present along the streamside which are not found in the surrounding forest. These include Carex disperma (two-seeded sedge), Dryopteris spinulosa, Equisetum sylvaticum, Galium triflorum (sweet-scented bedstraw), Geum macrophyllum, Lonicera involucrata, Smilacina trifolia, Thalictrum sparsiflorum and Stellaria longifolia.

In stand 3, the herbaceous cover includes many of the above, but with significantly lower cover values. As well, this stand forms a community distinct from the bordering forest, unlike stand 41.

The moderate bryoid cover in this community type is dominated by Climacium dendroides and Plagiomnium cuspidatum.

Throughout the mature coniferous forests surrounding Crow Lake, there are a number of small brooklets. These provide a shady wet habitat within the mesic forest and contain a number of interesting and

relatively uncommon species. Usually the stream course is lined with Alnus tenuifolia, four to five metres tall in a band 15 m wide. The actual streamside flora is found in a narrow zone along the stream. Common woody species are: Lonicera involucrata, Ribes hudsonianum, Rubus pubescens and Abies balsamea. Common graminoids include: Glyceria striata (fowl manna grass), Carex loliacea (rye-grass sedge), C. brunnescens (brownish sedge) and C. disperma and Calamagrostis canadensis. Equisetum spp., Galium triflorum, Viola palustris, Delphinium glaucum, Chrysosplenium iowense, Urtica gracilis, Thalictrum sparsiflorum, Arenaria lateriflora (blunt-leaved sandwort), Adoxa moschatellina (moschatel), Caltha palustris, Dryopteris spinulosa, Stellaria longipes and Matteuccia struthiopteris (ostrich fern) are the more common herbaceous species.

Calliergon cordifolium, Plagiomnium ellipticum and Climacium dendroides are the most common bryophytes of this community type.

This brookside flora is unlike the Alnus swamp community in that the latter is a distinct association, hummocky, and present in a broad zone, whereas the former is a narrow band of hygrophytic species along the stream channel edge.

7.3.6 Miscellaneous Wetland Habitats

Boggy Depression and Streamside Vegetation in Picea mariana - Feathermoss Forests.

There is a variety of wetland community subtypes within the extensive Picea mariana - feathermoss forests throughout the study area. Most of these are small subhygric to hygric, imperfectly- to poorly-drained depressions. There is also a distinct flora associated with the streams which flow through these forests.

Stand 66 (Figure 15, Appendix 11) describes one of the hygric depressions within the P. mariana - feathermoss forest. This site has an open canopy of P. mariana, 13 m tall, and is in a small valley. Salix myrtillifolia and S. planifolia (two per cent cover each) form a sparse low shrub layer. The former is also found in the dwarf shrub layer with a slightly higher cover (eight per cent).

The influence of the wetter terrain is shown by the presence of the following species in the understory: Equisetum sylvaticum (35 per cent cover), Ranunculus lapponicus (lapland buttercup) (two per cent cover), Rubus acaulis (one per cent cover), Listera cordata (heart-leaved twayblade) (one per cent cover), Smilacina trifolia (0.8 per cent cover), Pedicularis labradorica (0.5 per cent cover), Senecio pauperculus (0.1 per cent cover) and Parnassia palustris (grass-of-Parnassus) (0.1 per cent cover). The dominance by Equisetum spp. is quite common in similar habitats throughout the study area.

The bryoid layer has 95 per cent cover. Although feathermosses contribute 35 per cent cover, species of wetter terrain such as

Sphagnum warnstorfii (30 per cent cover), S. fuscum (25 per cent cover) and Aulacomnium palustre (10 per cent cover) are also common. The presence of Sphagnum warnstorfii in the wet inter-hummocks identifies the mesophytic moisture status of this environment (Vitt and Andrus 1977).

Within the closed feathermoss forests, there is a particular flora associated with the numerous small brooklets and seepages found there. Often this association is only a few metres wide and usually has the following species: Calamagrostis canadensis, Caltha palustris, Carex limosa, C. disperma and C. canescens, Smilacina trifolia, Equisetum sylvaticum, Pyrola secunda, Eriophorum spp. and Potentilla palustris. This is a rich flora in comparison to the surrounding feathermoss forest.

In some of the larger, wetter openings, the following species may be present in addition to those described above: Ribes hudsonianum, Stellaria longifolia, Galium trifidum, Habenaria hyperborea, Listera cordata, Ranunculus lapponicus, Salix myrtillifolia and Calamagrostis inexpansa. Carex aquatilis and C. rostrata are found along some of the deeper stream channels.

Associated with these wet areas are a variety of Sphagnum spp. and mosses and liverworts such as Hypnum pratense, Drepanocladus uncinatus, D. exannulatus, Aulacomnium palustre, Plagiomnium ellipticum and Plagiochila asplenoides.

Beaver Ponds and Dams.

Throughout the field season, trips were made along some of the watercourses in the study area in order to determine the flora associated with the semi-aquatic and aquatic habitats around beaver ponds and dams. Table 9 lists most of the species encountered, and indicates those which are most common.

7.4 Vegetation of a Recent Burn

Fire is an integral part of the boreal forest ecosystem (Rowe and Scotter 1973) and the mixedwood boreal forests which dominate the Crow Lake area are no exception. There is ample evidence of frequent fires in the past throughout the study area: large even-aged stands, distinct fire lines, charcoal layers in the soil, and burned stumps.

The most recent fire was in 1978, which burned a 248 ha parcel of land (1.9 per cent of study area) in the southeast corner of the study area (Figure 19). It also burned a much larger area to the south of the Crow Lake area. It was a moderate fire, and was quite patchy. Most of the burned stands were dense, closed Picea mariana - feathermoss forests and more open P. mariana treed peatlands (Coniferous Forest Types 5 and 6, respectively). Stands of Populus

Table 9

PLANT SPECIES FOUND ALONG BEAVER PONDS AND DAMS

Species commonly found on wet ground along pond margins

- Cardamine pensylvanica
- Chrysosplenium iowense
- + Epilobium glandulosum
- Epilobium leptophyllum
- Epilobium palustre
- Equisetum arvense
- + Geum macrophyllum
- Impatiens noli-tangere
- + Mentha arvensis var. villosa
- + Potentilla norvegica
- + Potentilla palustris
- Potentilla rivalis
- Ranunculus macounii
- Ranunculus pensylvanicus
- Ranunculus sceleratus
- + Rorippa islandica var. hispida
- Salix planifolia
- Stellaria crassifolia
- + Stellaria longifolia
- Stellaria longipes
- + Urtica gracilis
- + Marchantia polymorpha
- Drepanocladus sendtneri
- Drepanocladus uncinatus

Species commonly found in shallow water

- + Agrostis scabra
- Alopecurus aequalis
- + Calamagrostis canadensis
- Caltha natans
- + Carex aquatilis
- Carex atherodes
- Carex canescens
- Carex crawfordii
- + Carex diandra
- Carex limosa
- + Carex rostrata
- Cicuta bulbifera
- Equisetum fluviatile
- Galium trifidum
- + Glyceria borealis
- + Glyceria grandis
- Glyceria striata
- Hippuris vulgaris
- Lemna minor
- Luzula parviflora
- Polygonum amphibium var. stipulaceum
- Polygonum lapathifolium
- + Potamogeton alpinus
- + Potamogeton pusillus
- + Ranunculus circinatus
- + Ranunculus gmelinii
- + Rumex occidentalis
- + Scutellaria galericulata
- Sium suave
- + Utricularia minor
- Veronica americana
- Veronica scutellata
- + Drepanocladus aduncus
- Sphagnum teres

NOTE: Those marked with a '+' are likely to be present in greater abundance.

tremuloides on some of the drier knolls were only burned at the edges. The organic layer in the peatlands was only scorched a few centimetres below the surface, and there are many partially-burned snags still standing in the area.

The early successional plant communities which are established on the burned-over sites occur as a diverse mosaic of plant associations. The reason for the rapid change in plant associations over short distances is due to the variable nature of factors which control the post-fire plant development. These factors include: fire intensity, damage to pre-existing vegetation, topography, soil moisture status and availability of propagules.

Two early successional plant communities were sampled in the burned-over area. The first is an upland type, replacing a closed Picea mariana forest. The second is a wetland type, replacing a wet seepage Salix - Picea mariana community. A third P. mariana peatland transition forest (intermediate in soil moisture between the first two) was visited briefly.

The early successional upland community type (stand 48, Figure 15, Appendix 11) has replaced a closed forest which had approximately 90 per cent Picea mariana and 10 per cent Pinus banksiana 11 m high canopy cover (based on examination of old partially-burned snags). It is on a well-drained, xeric, sandy glaciofluvial ridge.

As yet, there has been little regrowth of woody species taller than 0.5 m. Salix bebbiana (five per cent cover) forms an open tall shrub layer (2.5 m height). Small amounts of S. bebbiana and Populus tremuloides (one per cent cover each) contribute to a sparse low shrub layer at two metre height.

Most of the early successional development has been in the herb-dwarf shrub layer (50 per cent cover). The herb-dwarf shrub stratum has a richness of 21 species. Dominant species are: Vaccinium myrtilloides (25 per cent cover), Ledum groenlandicum (15 per cent cover), Cornus canadensis (15 per cent cover), Calamagrostis canadensis (eight per cent cover) and Rosa acicularis (five per cent cover). Other species include Linnaea borealis, Epilobium angustifolium, Vaccinium caespitosum (dwarf bilberry), Elymus innovatus and Equisetum sylvaticum.

The bryoid layer has 12 per cent cover and is comprised mostly of Ceratodon purpureus (eight per cent cover) and Polytrichum strictum (three per cent cover).

This sampled early successional upland plant community represents the drier upland type. On the well-drained sites where there is more moisture, the herb-dwarf shrub cover is higher, and there is a noticeable increase in Equisetum spp. cover.

The second early successional community (stand 49, Appendix 11) represents the wetland post-fire type. It is located in an area of groundwater seepage in a hygric, poorly-drained depression. Before the

1978 fire this site was probably occupied by a Picea mariana - Salix planifolia community (based on examination of woody material).

The burn in this wet area was not as severe as on the drier upland sites. There has been good regrowth of Salix spp. from partially burned root crowns. S. planifolia has grown back to a height of 2.5 m (20 per cent and 25 per cent cover in the tall and low shrub strata, respectively). It is the only species above the herb-dwarf shrub layer.

The herb-dwarf shrub layer is species rich (32 species) with a cover of 40 per cent. The dominant species and their cover values are: Ledum groenlandicum (15 per cent), Rubus chamaemorus (six per cent), Salix myrtillifolia (four per cent), Pyrola secunda (four per cent), Smilacina trifolia (three per cent) and Carex aquatilis (three per cent). Carex disperma, Betula pumila, Linnaea borealis, Oxycoccus microcarpus and Salix pyrifolia are found in small amounts.

The bryoid layer (45 per cent cover) is better developed on this wet site, compared to the upland early successional communities. Eleven species are present with Sphagnum angustifolium (20 per cent cover), S. fuscum, S. teres and Ceratodon purpureus (each five per cent cover) as the major species.

The third post-fire community was only visited briefly. It occurs on a site which probably supported a Picea mariana peatland transition stand (Coniferous Forest Type 6, Table 5), and is intermediate between two other sampled stands, in terms of soil moisture.

There has been good regrowth in the low shrub and herb-dwarf shrub strata. Ledum groenlandicum (40 per cent cover), Vaccinium vitis-idaea (eight per cent cover) and Rubus chamaemorus (five per cent cover) are the major species. Small (average height = five centimetres) Picea mariana seedlings (0.5 per cent cover) indicate that this site will slowly develop into a forested plant community. The tallest woody vegetation in this stand is 1.5 m in height.

Before the 1978 fire, the bryoid cover was 100 per cent, with well developed Sphagnum hummocks. These hummocks were scorched on the surface and now the moss cover is only 20 per cent. Sphagnum fuscum, S. nemoreum and Polytrichum strictum are the dominant species.

8. SPECIAL FEATURES

There are a variety of special features occurring within the Crow Lake study area. These were identified in literature pertaining to the study area or by field observation. Special features are designated as such if they fall into one of the two following categories: a) they are of regional significance (i.e. have only limited occurrence in northeastern Alberta), b) they are uncommon within the study area.

Most of the special features listed below have been mentioned within the body of this report. They are shown on Figure 20.

1. Crow Lake

   Crow Lake is the largest and deepest water body within the study area. It has steep-sided, well defined margins and as such has high recreational potential (see Section 3.2.2 on land use). Crow Lake has local significance.

2. Rare Flora

   Section 6.2 lists eight vascular species which are considered rare in Alberta by Packer and Bradley (1984) or by Argus and White (1978). Seven of these rare species occur in wetland habitats. These rare species are: Lycopodium sitchense, Carex loliacea, C. scoparia, C. trisperma, C. vesicaria, Scirpus atrovirens var. pallidus, Juncus filiformus and Pedicularis parviflora. Most of these species are also rare within the study area. They are of high regional significance.

   The annotated species lists in Appendix 9 indicate the species which, while common throughout Alberta, are rare within the study area. They are of minor local and of no regional significance.

3. Uncommon Plant Communities

   a) Patterned Fen

      As discussed in Section 7.3.2 (Poor Fen Unit), this is a poorly-developed patterned fen. Because it is the only one in the study area, it has some local significance however, it has no regional significance.

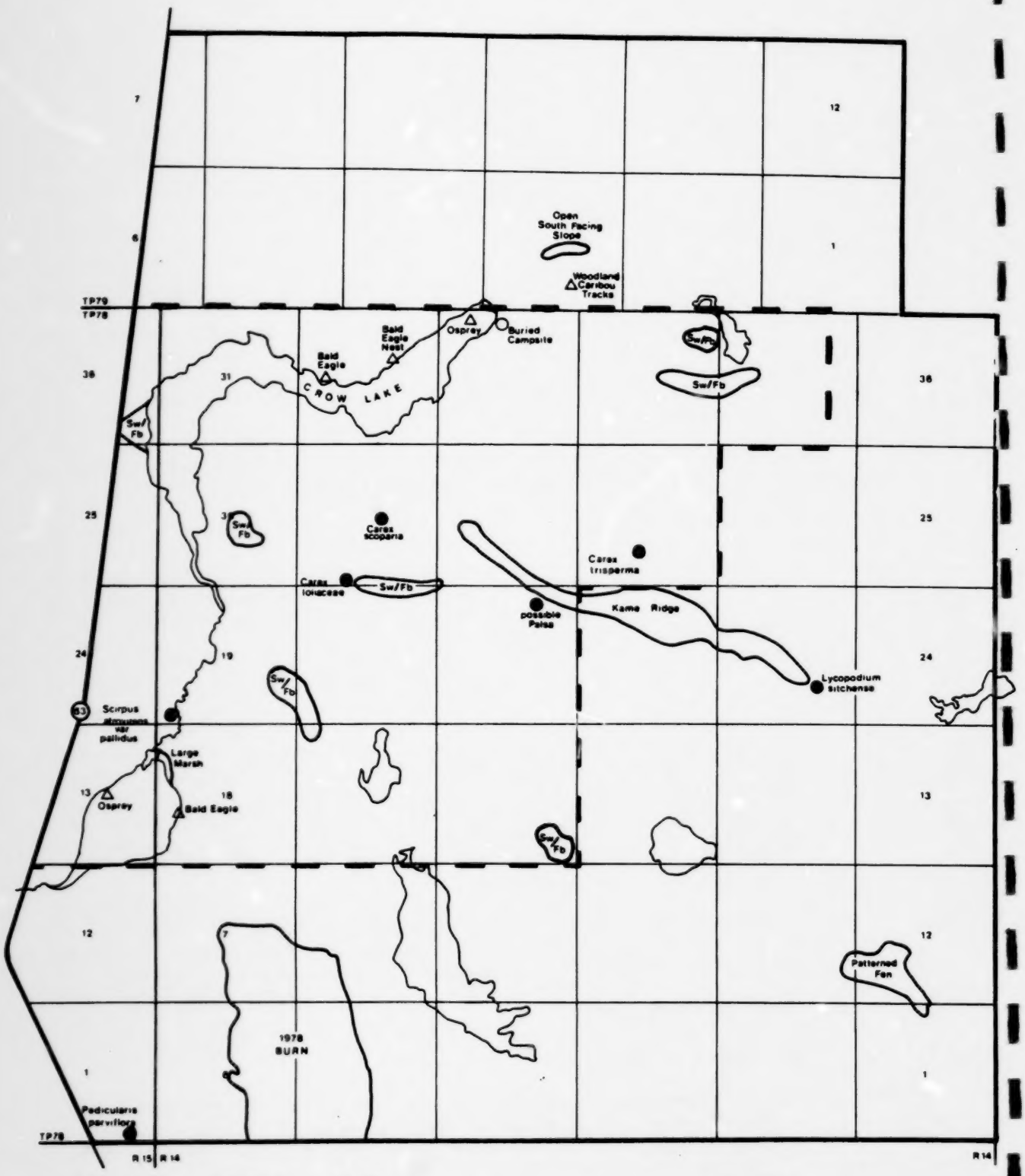


FIGURE 20 **CROW LAKE STUDY AREA**
SPECIAL FEATURES

Study Area
Core Area

Scale 1:50 000
Miles 1 0 1
Km. 1 0 1

b) Extensive Shore Marsh

The most extensive shore marsh community in the study area (stand 76) is located on the north end of "Little Crow Lake". Because it is the largest shore marsh in the study area it has some local significance. Regional importance is low.

c) Mature Picea - Abies Stands

There are several stands representing this forest type around Crow Lake (Figure 20). As these stands are not common in northeastern Alberta, they have high regional significance.

d) South-Facing Open Slopes

The one stand which represents this open, south-facing community type is described in Section 7.2.4 (stand 38). Several plant species found nowhere else in the study area are found on this open slope. The rareness of this community type within the study area gives it local significance. Regional significance is low.

4. Geomorphic Features

a) Large Kame Ridge

Small sandy glaciofluvial ridges are quite common within the study area (see Section 3.6). There is one which is much bigger than the others, and so merits mention as a special feature. It is in the centre of the study area and is approximately four kilometres long and 10 m high. It has some local significance. Regional importance is unknown.

b) Peat Palsa

Several interesting landforms which may be partially collapsed palsas occur within the study area. They are small (10 m diameter), raised (0.15-1.5 m high), crescent-shaped features found near the margin of several poor fens (e.g., stand 60). They are vegetated by stunted six-metre-tall Picea mariana, ericaceous shrubs and Sphagnum moss. Their occurrence is quite possible, as the study area is within the "localized permafrost zone" of northern Alberta (Ozoray 1974). Their morphology and site location is characteristic of palsas in the region (Steve Zoltai 1983, pers. com.) and palsas have been found as far south as the Lac La Biche area. In order to verify their presence as actual permafrost features, temperature profile records, taken late in summer, would be required.

If these features are palsas, they have high local and regional significance.

5. 1978 Burn

The recently burned area is considered to be a special feature because it provides the only examples of early successional community types within the study area. This gives it high local significance. It is not significant regionally.

6. Archaeological Site - Buried Campsite

Alberta Ecologial Survey has identified a buried campsite on the northeast shore of Crow Lake (Pollock 1977) (see Section 3.1.1). As well, there is good potential for further archaeological finds along Crow Lake. The buried campsite has some regional importance.

7. Vegetation Diversity

There are 16 upland and 12 wetland community types (excluding the post-burn early successional communities) identified within the study area (see Section 7). These community types represent most of the plant community diversity found within the Boreal Mixedwood Section. Most of the diversity of vegetation can be found within the core area (Figure 2). This diversity has high regional significance.

8. Uncommon Fauna

a) Bald Eagle

A bald eagle was seen flying near Crow Lake during the field season. Although an old nest was found along the northeast arm of Crow Lake (Figure 20), there is no evidence that bald eagles are presently nesting in the study area. Given the fact that Crow Lake provides optimum habitat for bald eagles, the evidence of their occurrence in the study area has regional significance.

b) Osprey

Osprey were seen on both Crow Lake and "Little Crow Lake". These sightings have some regional significance because there is a good chance that osprey are resident within the study area.

c) Caribou

Caribou tracks were noted in the upland sandy Pinus banksiana forest northeast of Crow Lake. Although there is suitable habitat for caribou within the study area, they usually range to the east of the Crow Lake area (Alberta. Fish and Wildlife Division 1981). Consequently, this sighting has only limited regional significance.

Appendix 1

AIR PHOTOGRAPH COVERAGE FOR THE CROW LAKE STUDY AREA

Date	Scale	Job No.	Photo Numbers	Type
1961 Sept.-Oct.	1:31 680		AS798 No. 66- 70 119-123 167-170 AS797 15- 18	Black and White
1976 October 1	1:50 000		AS1536 No. 88- 91 58- 62 26- 29	Black and White Infrared
1973 April 26	1:24 000	73-148	AS1275 No. 118-123	Black and White panchromatic
1978 June-August	1:15 000	78-50A	AS1775 No. 274-283 AS1776 112-121 AS1777 93-102 AS1778 110-119 AS1779 94-104 AS1780 102-110	Black and White panchromatic

Appendix 2

MAP COVERAGE FOR THE CROW LAKE STUDY AREA

Scale	Title
1:250 000	National Topographic Series 83-P
1:50 000	National Topographic Series 83-P/16
1:63 360	Special Geomorphic Landform Map; Alberta Land Inventory
1:760 320	Exploratory Soil Survey of Alberta, Map Sheets 83-O, 83-P, and 73-M, Soil Survey Exploratory Report 64-1
1:500 000	Hydrogeological Reconnaissance Map Series, Hydrogeology of the Pelican - Algar Lake area NTS 83-P, 84-A, Accompanies Earth Sciences Report 80-1; Alberta Research Council
1:84 480	Oil and Gas Area Map, House River Sheet; Alberta Energy and Natural Resources
1:190 080	Oil Sands Area Map, Athabasca South; Alberta Energy and Natural Resources
1:1 267 000	Geological Map of Alberta; Alberta Research Council, 1972
1:1 000 000	Bedrock Geology, Athabasca River, NTS 83, Map 1339A; Geological Survey of Canada
1:250 000	East Central Alberta Regional Groundwater Resource Inventory, NTS 83-P; Earth Sciences Division, Alberta Environment
1:750 000	Oil and Gas Fields and Main Pipelines in Alberta; Energy Resources Conservation Board
1:100 000	Alberta 1:100,000 Map Series, Forest Cover Series; Cartographic Services, Alberta Energy and Natural Resources
1:50 000	Provincial Record Series, Forest Cover; Alberta Forest Service, Alberta Energy and Natural Resources
1:63 360	Forest Inventory Maps, Phase I (broad); Resource Evaluation and Planning Division, Alberta Energy and Natural Resources

Scale	Title
1:31 680	Forest Inventory Maps, Phase 2 (detailed); Resource Evaluation and Planning Division, Alberta Energy and Natural Resources
1:15 000	Forest Inventory Maps, Phase 3 (very detailed); Resource Evaluation and Planning Division, Alberta Energy and Natural Resources
1:250 000	Canada Land Inventory (C.L.I.) Land Capability Maps, 83P; Environment Canada a) Land Capability for Wildlife - Waterfowl b) Land Capability for Wildlife - Ungulates c) Land Capability for Forestry d) Land Capability for Recreation
1:50 000 or 1:63 360	Alberta Land Inventory (A.L.I.) Land Capability Maps, Alberta Energy and Natural Resources a) Land Capability for Waterfowl b) Land Capability for Ungulates c) Land Capability for Forestry d) Land Capability for Outdoor Recreation e) Soil Capability for Agriculture
1:250 000	Capability for Sport Fish; Alberta Land Inventory
1:50 000	Fish Resource Maps; Fisheries Branch, Alberta Energy and Natural Resources
1:250 000	Wildlife Key Area Map NTS 83-P; Fish and Wildlife Division, Alberta Energy and Natural Resources
1:250 000	Recreation Facilities Inventory; Alberta Land Inventory
1:63 360	Soil Capability for Agriculture; Canada Land Inventory (C.L.I.), Environment Canada
1:15 000	Fire Burn Maps; Alberta Energy and Natural Resources (based on Phase 3 maps)
1:250 000	Provincial Access Maps; Alberta Energy and Natural Resources
1:63 360	Land Registry Maps; Alberta Recreation and Parks

Many of the above maps are available from:

Energy and Natural Resources
Alberta Bureau of Surveying and Mapping
Map and Air Photo Reference Library
2nd Floor, North Tower
Petroleum Plaza
9945 - 108 Street
Edmonton, Alberta
T5K 1G6
(403) 427-7417

Information on where to obtain all the maps listed above is found in the publication:

Natural Resources Information Directory 1984
Alberta Energy and Natural Resources
Resource Evaluation and Planning Division

Veg. Plot No. 1.

Project I.D. 8.

Legal 14.

Location:

Biog. Z. 31.

IBP Code 33.

Veg. Type 28.

Landform 33.

Elevation 36.

Slope 40.

Aspect 43.

Soil 44.

Sociation Name:

Site Position Diagram (refer to data form no. _____)

Photo roll no. _____

Photo no. _____

Scale

Direction ←→

General Description and Remarks:

47. Moisture Regime
1. very xeric
2. xeric
3. subxeric
4. submesic
5. mesic
6. subhygric
7. hygric
8. subhydric
9. hydric

48. Drainage
rapidly
well
mod. well
imperfectly
poorly
very poorly

49. Site Position
crest
upper slope
middle slope
lower slope
toe
depression
level

50. Stability Index
unstable
rapid change
mod. change
slow change
stable
climax

51. Microtop
smooth
micro-mound
slightly mound
mod. mound
strongly mound
severely mound
extr. mound
ultra mound

Rock 52.

Humus 54.

Min. Soil 56.

Deadfall 58.

Water 60.

T. Unveg. 62.

% Cover	Species	Cover	Av. Hgt.	DBH	Rings
Tree C. I 64.					
Tree C.II 66.					
Shrub C. I 68.					
Shrub C. II 70.					
72. Herb Dwarf Shrub		74. Bryoid			

Plot No. 1. _____ Date: _____ Other Obs: _____

LYR	CODE	%	SPECIES	LYR	CODE	%	SPECIES
8.	10.	14.					

Appendix 4

SUBSURFACE LAND DISPOSITIONS - AUGUST 1983

Lease No.	Holder	Location in Study Area	Expiry Date
0581120226 P & NG	Petro-Canada Exploration Inc. Canada-Cities Service Ltd. Esso Resources Canada Ltd.	Sec. 1, 2, 3, 10-12 79-14-W4 - above level of McMurray Formation	29-12-86
0581120228 P & NG	Petro-Canada Exploration Inc. Canada-Cities Service Ltd. Esso Resources Canada Ltd.	Sec. 4-9 79-14-W4 - McMurray Formation	29-12-86
0982060015 Oil Sands	Petro-Canada Exploration Inc. Canada-Cities Service Ltd. Esso Resources Canada Ltd.	Sec. 1-12 79-14-W4 - McMurray Formation	8-6-2003
20506 P & NG	Canadian Superior Oil Ltd.	Sec. 1, 12 78-15-W4 Sec. 7 78-14-W4 - above base of Mannville Zone	continued 31-3-83
20503 P & NG	Canadian Superior Oil Ltd.	Sec. 2, 3, 10-12 78-14-W4 - above base of Mannville Zone	continued 31-3-83
0583040161 P & NG	Bow Valley Industries Ltd. Canadian Superior Oil Ltd. Merland Exploration Ltd.	Sec. 11 78-15-W4 (not shown on Figure 4)	26-4-86

Appendix 5

WELLSITE INFORMATION

Name	Type	Location	Date Drilled	Present Status
CDN - SUP Portage MSL 802287	GAS	LS 6 Sec. 12 78-15-W4	Jan. - Feb. 1981	suspended
CDN - SUP Thornbury MSL 802288	GAS	LS 10 Sec. 11 78-14-W4	February 1981	suspended
CDN - SUP Thornbury MSL 802289	GAS	LS 10 Sec. 22 78-14-W4	February 1981	abandoned
Pex PCEJ Thornbury (Petro-Canada)	observation well for Oil Sands data	LS 10 Sec. 8 79-14-W4	February 1981	observation well
PEX PCEJ Thornbury	observation well for Oil Sands data	LS 10 Sec. 10 79-14-W4	February 1981	observation well

Appendix 6

CLIMATE NORMALS FOR STATIONS NEAR CROW LAND
1951 - 1980

6.1 Temperature and Precipitation

Fort McMurray Airport — 56° 39'N 111° 13'W 369m
100 km NNE of Crow Lake

	Jan	Feb	Mar	Apr	May
Daily Maximum Temperature	-16.5	-9.0	-2.2	8.7	16.9
Daily Minimum Temperature	-27.1	-21.8	-16.1	-4.5	2.4
Daily Temperature	-21.8	-15.4	-9.2	2.1	9.7
Extreme Maximum Temperature	10.6	15.0	18.9	30.2	32.8
Years of Record	37	37	37	37	37
Extreme Minimum Temperature	-50.0	-50.6	-44.4	-35.0	-13.3
Years of Record	37	37	37	37	37
Rainfall	0.5	0.6	0.9	7.3	33.4
Snowfall	26.4	21.9	24.2	13.5	2.7
Total Precipitation	22.7	18.8	20.7	20.5	36.3
Days with Rain	.	.	1	4	9
Days with Snow	14	12	11	5	1
Days with Precipitation	14	11	11	8	9

Lac La Biche — 54° 46'N 111° 58'W 559m
106 km S of Crow Lake

	Jan	Feb	Mar	Apr	May
Daily Maximum Temperature	-13.8	-7.3	-2.1	7.7	15.7
Daily Minimum Temperature	-22.9	-17.8	-13.2	-2.4	4.6
Daily Temperature	-18.4	-12.5	-7.3	2.1	9.9
Extreme Maximum Temperature	8.3	11.7	12.8	23.3	30.0
Years of Record	15	15	15	15	16
Extreme Minimum Temperature	-48.3	-48.3	-36.7	-31.7	-11.1
Years of Record	15	15	15	15	16
Rainfall	0.5	0.2	2.1	4.9	30.5
Snowfall	32.8	25.1	30.5	24.8	2.8
Total Precipitation	33.4	25.3	32.8	27.9	32.0
Days with Rain	0	0	1	2	11
Days with Snow	17	14	12	5	0
Days with Precipitation	13	10	13	8	9

Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
21.0	23.1	21.4	14.8	8.6	-3.5	-12.2	5.9
7.0	9.5	8.0	3.1	-2.0	-12.7	-21.7	-6.3
14.0	16.4	14.8	9.0	3.3	-8.2	-17.0	-0.2
36.1	35.6	33.3	30.6	28.4	18.9	10.0	36.1
37	37	37	37	37	37	37	
-4.4	-3.3	-2.8	-15.6	-22.8	-37.8	-47.2	-50.6
37	37	37	37	37	37	37	
64.1	75.4	76.6	54.4	16.2	2.5	0.9	332.8
T	0.0	0.0	4.0	12.7	29.1	29.3	163.8
64.1	75.4	76.6	58.5	28.1	25.2	25.0	471.9
12	14	13	11	7	2	1	74
*	0	0	1	5	13	14	76
12	14	13	12	10	13	13	140

Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
20.1	22.6	21.3	15.1	9.1	-1.7	-9.2	6.5
9.4	11.9	10.5	5.2	0.3	-9.6	-17.3	-3.4
14.3	17.0	15.7	10.1	4.7	-5.5	-13.7	1.4
32.2	33.3	31.7	30.0	25.0	20.0	10.6	33.3
16	16	16	15	15	15	15	
-1.7	2.2	-1.7	-11.1	-18.3	-35.0	-41.7	-48.3
16	16	16	16	15	15	15	
87.1	90.0	74.0	51.9	17.2	1.8	4.9	365.1
0.0	0.0	0.0	1.8	12.7	38.1	39.0	207.6
87.1	90.0	74.0	54.8	29.0	33.9	42.0	562.2
10	14	13	11	6	1	2	71
0	0	0	1	2	13	16	80
13	14	12	11	9	12	15	139

May Lookout — 55° 37'N 112° 21'W 896m
28 km SW of Crow Lake

	Jan	Feb	Mar	Apr	May
Daily Maximum Temperature	13.8	17.6	19.9	18.4	11.7
Daily Minimum Temperature	3.2	7.7	10.1	8.8	3.6
Daily Temperature	8.6	12.8	15.1	13.6	7.8
Extreme Maximum Temperature	27.8	30.6	30.0	29.4	26.7
Years of Record	16	16	16	15	15
Extreme Minimum Temperature	-10.0	-2.2	2.0	-1.1	-11.7
Years of Record	13	15	16	16	14
Rainfall	46.1	102.9	115.9	99.8	69.2
Snowfall	8.1	0.3	0.0	0.0	6.0
Total Precipitation	54.1	103.1	115.9	99.8	75.7
Days with Rain	10	13	15	15	13
Days with Snow	2	0	0	0	2
Days with Precipitation	11	13	15	15	14

NOTE: records for summer months only

Christina Lookout — 55° 35'N 111° 51'W 823m
19 km SE of Crow Lake

	May	Jun	Jul	Aug
Daily Maximum Temperature	15.7	19.2	21.2	19.5
Daily Minimum Temperature	2.8	7.4	9.8	8.3
Daily Temperature	M	13.3	15.5	13.9
Extreme Maximum Temperature	28.0	33.3	31.0	30.0
Years of Record	8	13	14	12
Extreme Minimum Temperature	-8.0	-3.3	1.0	0.0
Years of Record	5	14	14	11
Rainfall	37.9	90.8	88.4	77.7
Snowfall	4.0	0.0	0.0	0.0
Total Precipitation	48.9	90.8	88.4	77.7
Days with Rain	10	14	15	15
Days with Snow	2	0	0	0
Days with Precipitation	M	15	16	14

NOTE: M - data missing

NOTE: Data for Fort McMurray is based on a full 30 years record.

Data for Lac La Biche, May and Christina Lookouts are adjusted normals based on 5 to 19 years, inclusive from 1951 to 1980 and any other available data from 1931 to 1950.

Temperature - °C
Rainfall - mm
Snowfall - cm
Total precip. - mm

6.2 Mean Wind Speed (km/h) and Prevailing Direction

Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Fort McMurray	8.6 E	9.1 E	9.9 E	11.2 ESE	11.4 E	9.8 E	9.2 W	8.9 SW	9.6 W	10.6 E	9.3 E	8.4 E	9.7 E
Lac La Biche	9.3 NW	9.9 S	10.5 SE	11.9 S	11.7 NW	10.4 W	9.4 W	9.2 W	10.6 WNW	12.1 W	10.6 S	9.6 SE	10.4 NW

Appendix 7

SOIL PROFILE DESCRIPTIONS

Soils data is from Wayne Tedder of the Public Lands Division, Alberta Energy and Natural Resources, Edmonton.

Soil profile numbers 1, 3, 17 and 20 have been omitted due to problems in their classification. Profile 21 is not recorded because it is not a soil profile but a description of a gravel pit exposure.

Profile descriptions follow the format outlined in the Canadian System of Soil Classification (Canada Soil Survey Committee 1978), although these appendices present only part of the information (color, texture and structure) normally contained in a complete profile description.

Soil profile locations are shown in Figure 13.

A subscript number (1 or 2) designates two distinct horizons of the same type. The postscript II appearing with a horizon indicates that it is composed of a different genetic material than the upper horizons in the profile (usually appears when a till is overlain by sandy glaciofluvial veneer).

Soil Descriptions of the Brunisolic Profiles

Pit No.: 2 — Gleyed Eluviated Eutric Brunisol

Site Description: Upper slope; south aspect; 6-9% slope; imperfectly drained; glaciofluvial veneer over ridged moraine; closed, black spruce - feathermoss forest.

Horizon	Depth cm	Description
L-H	10-0	
Ae	0-12	Pinkish grey (7.5 YR 6/2 m); sand; very weak, fine platy.
Bm	12-27	Dark yellowish brown (10 YR 4/4 m); sand; single grain.
II Cgj	27+	Reddish brown (2.5 Y 5/4 m); sandy loam; amorphous; common, fine, distinct mottles.

Pit No.: 5 — Eluviated Eutric Brunisol

Site Description: Upper slope; complex 3-5% slope; well drained; glaciofluvial veneer over subdued moraine; mesic, herbaceous aspen forest.

Horizon	Depth cm	Description
L-H	5-0	
Ae	0-8	Grey (10 YR 5.5/1 m); loamy sand to sand; weak, fine platy.
Bm	8-20	Yellowish brown (10 YR 5/4 m); loamy sand to sand; very weak, fine subangular blocky.
II BC	20-34	Dark yellowish brown (10 YR 4/3.5 m); clay loam; very weak, fine subangular blocky.
II C	34+	Very dark greyish brown (10 YR 3/2 m); clay; pseudoplaty to weak, fine to medium subangular blocky.

Pit No.: 6 — Eluviated Eutric Brunisol

Site Description: Slope crest; complex 3-5% slope; well drained; undulating glaciofluvial over moraine; black spruce / jackpine - feathermoss forest.

Horizon	Depth cm	Description
L-H	10-0	
Ae	0-6	Light brownish grey (10 YR 6/2 m); sand; single grain.
Bm	6-23	Dark yellowish brown (10 YR 4/5 m); loamy sand; single grain.
II C	23+	Yellowish brown (10 YR 5/3.5 m); sandy loam to sandy clay loam; weak, medium subangular blocky to amorphous.

Pit No.: 7 — Eluviated Dystric Brunisol

Site Description: Slope crest; south aspect; 16-30% slope; well drained; ridged glaciofluvial kame; aspen - white spruce forest.

Horizon	Depth cm	Description
L-H	6-0	
Ahe	0-2	Dark greyish brown (10 YR 4/2 m); loamy sand to sand; single grain.
Ae	2-11	Greyish brown (10 YR 5/2 m); sand; weak; fine platy.
Bm	11-26	Dark yellowish brown (10 YR 4/4 m); loamy sand; single grain.
C_1	26-38	Yellowish brown (10 YR 5/6 m); loamy sand to sand; single grain.
C_2	38+	Dark yellowish brown (10 YR 4/6 m); sand; single grain.

Pit No.: 9 — Eluviated Dystric Brunisol

Site Description: Upper slope; north aspect; complex 6-15% slope; well drained; subdued glaciofluvial over moraine; white spruce - aspen forest.

Horizon	Depth cm	Description
L-H	8-0	
Ae	0-8	Light brownish grey (10 YR 6/2 m); sand; single grain.
Bm	8-36	Dark yellowish brown (10 YR 4/4 m); loamy sand; very weak, fine to medium subangular blocky to single grain.
II C	36+	Dark brown (10 YR 4/3 m); clay loam; very weak, fine to medium subangular blocky.

Pit No.: 10 — Eluviated Dystric Brunisol

Site Description: Mid-slope; southwest aspect; complex 6-9% slope; well drained; ridged and subdued glaciofluvial kame; mesic, herbaceous aspen forest.

Horizon	Depth cm	Description
L-H	7-0	
Ahej	0-1	Dark greyish brown (10 YR 4/2 m); sand; single grain.
Ae	1-17	Light brownish grey (10 YR 6/2 m); sand; single grain.
Bm	17-36	Dark yellowish brown (10 YR 4/6 m); sand; single grain.
BC	36-53	Yellowish brown (10 YR 5/4 m); sand; single grain.
C	53+	Dark yellowish brown (10 YR 4/4 m); sand; single grain.

Pit No.: 11 Eluviated Eutric Brunisol

Site Description: Slope crest; west aspect; 9-30% slope; well drained; hummocky glaciofluvial deposits; jackpine woods.

Horizon	Depth cm	Description
L-H	2-0	
Ae	0-10	Light brownish grey (10 YR 6/2 m); sand; single grain.
Bm	10-20	Dark yellowish brown (10 YR 4/6 m); sand; single grain.
BC	20-38	Yellowish brown (10 YR 5/6 m); sand; single grain.
C	38+	Yellowish brown (10 YR 5.5/6 m); sand; single grain.

Pit No.: 13 Eluviated Dystric Brunisol

Site Description: Upper slope; north aspect; complex 9-15% slope; well drained; ridged glaciofluvial deposits; black spruce / pine - feathermoss forest.

Horizon	Depth cm	Description
L-H	disturbed	
Ae	0-8	Light brownish grey (10 YR 6/2 m); sand; single grain.
Btj	8-24	Dark yellowish brown (10 YR 4/4 m); sandy loam to sandy clay loam; weak, fine subangular blocky to amorphous.
BC	24-39	Dark yellowish brown (10 YR 4/6 m); loamy sand; single grain.
C	39+	Yellowish brown (10 YR 5/6 m); loamy sand to sand; single grain.

Pit No.: 14 Eluviated Dystric Brunisol

Site Description: Mid-slope; south aspect; 6-9% slope; well drained; inclined glaciofluvial deposits; pine - aspen woods.

Horizon	Depth cm	Description
L-H	8-0	
Ae	0-12	Light brownish grey (10 YR 6.5/2 m); sand; single grain.
Bm	12-27	Strong brown (7.5 YR 4/6 m); sand; single grain.
BC	27-42	Yellowish brown (10 YR 4.5/6 m); sand; single grain.
C	42+	Yellowish brown (10 YR 5/6 m); sand; single grain.

Soil Descriptions of the Luvisolic Profiles

Pit No.: 16 — Brunisolic Gray Luvisol

Site Description: Level area; moderately well drained; glaciofluvial veneer over level moraine; mesic, herbaceous aspen forest.

Horizon	Depth cm	Description
L-H	8-0	
Ae_1	0-6	Greyish brown (10 YR 5/2 m); loamy sand; moderate, fine platy.
Bm	6-11	Dark yellowish brown (10 YR 4/5); sand to loamy sand; moderate, fine platy.
Ae_2	11-17	Dark greyish brown (10 YR 4.5/2 m); sandy loam to loamy sand; weak, fine platy.
II Bt	17-38	Dark yellowish brown (10 YR 4/4 m); sandy clay loam; very weak; fine subangular blocky.
II C	38+	Dark brown (10 YR 4/3 m); clay loam to sandy clay loam; weak, fine subangular blocky to amorphous.

Pit No.: 18 — Brunisolic Gray Luvisol

Site Description: Slope crest; east aspect; 5% slope; well drained; ridged glaciofluvial kame; pine - aspen - white spruce forest.

Horizon	Depth cm	Description
L-H	8-0	
Ae_1	0-5	Greyish brown (10 YR 5/1.5 m); loamy sand; strong, fine platy.
Bm	5-17	Yellowish brown (10 YR 5/4.5 m); sandy loam; moderate fine platy.
Ae_2	17-28	Yellowish brown (10 YR 5/5 m); loamy sand; weak, fine platy.
II Bt	28-61	Dark yellowish brown (10 YR 4.5/4 m); sandy clay loam; weak, fine subangular blocky to grandular.
II BC	61+	Dark greyish brown (10 YR 4/2 m); clay loam; amorphous.

Pit No.: 19 Brunisolic Gray Luvisol

Site Description: Upper slope; north aspect; 5% slope; moderately well to imperfectly drained; undulating moraine; white spruce - aspen forest.

Horizon	Depth cm	Description
L-H	8-0	
Ae	0-8	Greyish brown (10 YR 5/2 m); loamy sand; strong, fine platy.
Bm	8-13	Brown (10 YR 4.5/3 m); loamy sand to sandy loam; moderate, fine platy.
Bt	13-26	Dark brown (10 YR 4/2.5 m); sandy loam to sandy clay loam; weak, fine to medium subangular blocky.
II BC	26-38	Brown (10 YR 5/3 m); clay loam; moderate to strong, fine subangular block.
II Cgj	38+	Dark greyish brown (2.5 YR 4/2 m); clay loam; moderate pseudoplaty; many, fine to medium, faint mottles.

Pit No.: 22 Orthic Gray Luvisol

Site Description: Mid-slope; northeast aspect; 3% slope; moderately well to imperfectly drained; glaciofluvial veneer over level moraine; mixedwood forest.

Horizon	Depth cm	Description
L-H	7-0	
Ae	0-12	Greyish brown (10 YR 5.5/2 m); loamy sand to sand; moderate, fine platy.
Bt	12-27	Brown (10 YR 5/3 m); sandy loam; moderate, medium to coarse subangular blocky.
II BC	27-40	Brown (10 YR 5/3 m); clay loam; very weak, fine subangular blocky.
II Cgj	40+	Very dark greyish brown (10 YR 3/2 m); clay loam; moderate pseudoplaty; many, fine, faint mottles.

Pit No.: 23 Brunisolic Gray Luvisol

Site Description: Slope crest; complex 1-5% slope; moderately well drained; glaciofluvial veneer over level to undulating moraine; mature spruce - fir forest.

Horizon	Depth cm	Description
L-H	9-0	
Ahe	0-7	Greyish brown (10 YR 5/2 m); loamy sand; strong, fine platy.
Bm	7-17	Brown (10 YR 4.5/3 m); loamy sand; moderate, medium platy.
Bt	17-26	Dark brown (10 YR 3.5/3 m); sandy clay loam; weak, fine to medium subangular blocky.
II BC	26-61	Very dark greyish brown (10 YR 3/2 m); clay loam; amorphous.
II C	61+	Very dark greyish brown (2.5 Y 3.5/2 m); clay loam to clay; strong, fine pseudoblocky.

Pit No.: 24 Brunisolic Gray Luvisol

Site Description: Upper slope; northeast aspect; 7% slope; well drained; undulating moraine; mature aspen - white spruce forest.

Horizon	Depth cm	Description
L-H	8-0	
Ae	0-10	Greyish brown (10 YR 5/2 m); loamy sand; strong, fine platy.
Bm	10-27	Yellowish brown (10 YR 5/4 m); sandy loam; strong, fine to medium platy.
Bt_1	27-45	Dark brown (10 YR 4/3.5 m); sandy clay loam; weak, fine to medium subangular blocky.
Bt_2	45-57	Dark brown (10 YR 4/3.5 m); sandy clay loam, weak, fine subangular blocky.
C	57+	Very dark greyish brown (10 YR 3/2 m); clay loam, amorphous.

Pit No.: 25 Brunisolic Gray Luvisol

Site Description: Upper slope; north aspect, 2-9% slope; moderately well drained; undulating moraine; closed black spruce - feathermoss forest.

Horizon	Depth cm	Description
L-H	11-0	
Ae	0-6	Dark greyish brown (10 YR 4/1.5 m); loamy sand; strong, fine platy.
Bm	6-24	Dark yellowish brown (10 YR 4/6 m); sandy loam; strong, fine platy.
Bt	24-34	Dark yellowish brown (10 YR 4/4 m); clay loam to sandy clay loam; weak, fine to moderate subangular blocky.
BC	34-60	Dark brown (10 YR 4/3 m); clay loam; weak, fine angular blocky to amorphous.
C	60+	Very dark greyish brown (10 YR 3/2 m); sandy clay; amorphous.

Soil Description of the Gleysolic Profile

Pit No.: 15 Orthic Gleysol

Site Description: Shallow depression; poorly drained; peat veneer over glaciofluvial deposits; open black spruce peatland margin.

Horizon	Depth cm	Description
Of	25-0	
Ahej	0-4	Dark yellowish brown (10 YR 3.5/4 m); sandy loam; very weak, fine platy.
Bm	4-18	Dark brown (7.5 YR 3/4 m); sandy loam; strong, fine granular.
Cg	18+	Olive (5 Y 5/3 m); sandy loam; many, medium, prominent dark yellowish brown (10 YR 4/6 m) mottles; weak, fine granular.

Soil Descriptions of the Organic Profiles

Insufficient sampling was done to classify to organic soils to the Subgroup level. Classification at the Great Group level is tentative.

Pit No.: 4	Fibrisol
Site Description:	Level, depressional location; very poorly drained; groundwater seepage; 30 cm to groundwater table; horizontal poor fen; open treed black spruce peatland.
Profile Comments:	Fibric throughout, down to 1 m depth; numerous charcoal layers; pH 4.0-4.5 throughout; surface burned in 1978.

Pit No.: 8	Fibrisol
Site Description:	Level, depressional location; very poorly drained; 50 cm to groundwater table; depressional poor fen; open treed black spruce peatland.
Profile Comments:	Upper tier mostly undercomposed; Van Post scale 1-3.

Pit No.: 12	Mesisol
Site Description:	Level, depressional location; very poorly drained; 10 cm to groundwater table; horizontal poor fen; open treed black spruce peatland.
Profile Comments:	Mesic peat at 80 cm; interlayered with fibric material throughout.

Pit No.: 26	Mesisol
Site Description:	Level, depressional location; very poorly drained; 10 cm to groundwater table; horizontal poor fen; open treed black spruce peatland.
Profile Comments:	Top 70 cm is fibric peat; charcoal and mesic peat between 70 cm and 100 cm.

Appendix 8.1

ANNOTATED LIST OF VASCULAR PLANTS

POLYPODIACEAE

Dryopteris spinulosa (Muell.) Watt - common and locally abundant; mesic depressions in mixedwoods, shaded mesic streamsides, lakeshores; 4S

Gymnocarpium dryopteris (L.) Newm. - occasional; mesotrophic to eutrophic habitats such as, Alnus thickets, mesic mixedwoods, moist streamsides; 2S

Matteuccia struthiopteris (L.) Todaro - uncommon though locally abundant; forming patches, shaded mesic Alnus streamsides in mature Picea - Abies forests; 1S

EQUISETACEAE

Equisetum arvense L. - common; mesic mixedwoods, feathermoss forests, wet sandy lakeshores; 12S

Equisetum fluviatile L. - occasional; aquatic emergent, growing in sand or mud substrate, lakeshores, along placid streamsides, wet Carex meadows; 2S

Equisetum hyemale L. var. affine (Engelm.) A.A. Eat. - rare; only one occurrence in moist shallow gully in Pinus banksiana forest; 0S

Equisetum pratense Ehrh. - common; mature Picea glauca forests, moist Populus tremuloides stands; 6S

Equisetum scirpoides Michx. - common; moist feathermoss forests, mesic mixedwoods, sandy lakeshores; 7S

Equisetum sylvaticum L. - widespread; can form extensive patches; moist depressions in mature mixedwoods, feathermoss forests, moist streamsides; 18S

LYCOPODIACEAE

Lycopodium annotinum L. - common; found in a variety of habitats - clearings, drier areas in mixedwoods to mossy Alnus streamsides; 21S

Lycopodium clavatum L. - occasional; sandy dry Pinus banksiana forests; 1S

Lycopodium complanatum L. - common; dry and mesic mixedwoods, dry Pinus forests; 6S

Lycopodium obscurum L. - occasional; dry to mesic mixedwoods; 2S

1 Lycopodium sitchense Rupr. - rare; Pinus forests, considered rare in Alberta by Argus and White (1978); 1S

PINACEAE

Abies balsamea (L.) Mill. - occasional as canopy co-dominant in mature Picea - Populus and Picea stands, especially on north and east aspects and on kame ridges; common and locally abundant as saplings in mesic mixedwoods; 21S

Larix laricina (Du Roi) K. Koch - occasional open Picea mariana peatland, especially wetter sites; occurs sporadically in closed P. mariana stands; 15S

Picea glauca (Moench) Voss - widespread; dominant and co-dominant in pure and mixed stands, found on variety of habitats, although most common on mesic upland sites; 27S

Picea mariana (Mill.) BSP. - widespread; abundant, forming pure stands or mixed with Pinus on mesic uplands, extensive in mesic to wet open peatlands; 41S

Pinus banksiana Lamb. - widespread; forms pure open stands in dry sandy kame and glaciofluvial deposits, on more mesic sites is mixed with P. mariana and other tree species; 25S

TYPHACEAE

Typha latifolia L. - occasional; forms narrow bands along outer edges of emergent Carex vegetation along lakeshores and ponds, occasional along channel margins of slow-moving stream; 3S

SPARGANIACEAE

Sparganium chlorocarpum Rydb. - uncommon; found once in deep channel of Crow Creek, probably more common; flowers in late July; 0S

NAJADACEAE

Potamogeton alpinus Balbis var. tenuifolius (Raf.) Ogden - occasional; beaver ponds; 0S

Potamogeton filiformis Pers. - common; Crow Lake and smaller ponds, forms extensive submergent mosses in shallow water; 0S

Potamogeton pusillus L. - common; along shoreline in shallow water of Crow Lake, and in beaver ponds; 0S

Potamogeton richardsonii (Benn.) Rydb. - common and locally abundant; shallow water of lakes; flowers in early July; OS

JUNCAGINACEAE

1 Scheuchzeria palustris L. var. americana Fern. - common and locally abundant; moist to wet Carex fens, poor fens, ericaceous peatlands, often as a co-dominant; flowers late June and in July; 8S

ALISMACEAE

Sagittaria cuneata Sheld. - common; floating aquatic in shallow water in lakes and ponds; OS

GRAMINEAE

Agrostis scabra Willd. - common; mesic and wet habitats - Salix stands, Carex fens, lake and beaver pond margins, occasional in mesic mixedwood depressions; flowers in late July; 2S

Alopecurus aequalis Sobol. - occasional; tops of beaver dams, pond margins and lakeshores; flowers in late July; 1S

Beckmannia syzigachne (Steud.) Fern. - uncommon; sandy lakeshores and wet seismic lines; maturing in late July; OS

Bromus ciliatus L. - occasional; disturbed sites along dry sandy road and seismic lines; may be an exotic species; OS

Calamagrostis canadensis (Michx.) Beauv. - widespread; mesic mixedwoods, wet Salix and Alnus swamps, margins of emergent Carex fens, ponds and lakes, dominant in wet streamside meadows; maturing in late July; 26S

Calamagrostis inexpansa A. Gray - uncommon; lakeshore and Carex marshes; 1S

Calamagrostis neglecta (Ehrh.) Gaertn. - rare; found once in wet streamside marsh; 1S

Elymus innovatus Beal - widespread; mesic Populus tremuloides stands, dry Pinus forests, burned-over uplands, open slopes, seismic lines, occasional in Picea - feathermoss forests; flowers in late June - early July; 20S

Glyceria borealis (Nash) Batchelder - occasional; beaver pond margins and lakeshores, usually grows in mud substrates; flowers by late July; 2S

Glyceria grandis S. Wats. - common; in water along margins of beaver ponds, lakeshores and in wet herbaceous meadows; flowers in July; 3S

Glyceria striata (Lam.) Hitchc. - occasional; along streams, tops of beaver dams and pond margins; OS

Oryzopsis pungens (Torr.) Hitchc. - common; sandy, dry, oligotrophic forests, dry south-facing slopes; matures in late June; 5S

Phleum pratense L. - rare; one specimen collected along forestry winter road; exotic species; OS

Poa alpina L. - rare; noted from one site along moist, sandy road; may be an exotic species; OS

Poa palustris L. - occasional; mesic Populus tremuloides forests, on hummocks in Salix swamps and along lakeshores; matures in late July; 3S

Schizachne purpurascens (Torr.) Swallen - uncommon; found once on open south-facing slope; 1S

CYPERACEAE

Carex aquatilis Wahlenb. - widespread; wet habitats in a variety of nutrient regimes - streamsides, beaver ponds, lake margins and wet meadows, sparse in wet open Picea peatlands, co-dominant with C. rostrata in marshes, co-dominant with C. limosa in poor fens; matures in mid July; 19S

Carex atherodes Spreng. - uncommon; wet habitats, tops of beaver dams, streamside marshes; 1S

Carex aurea Nutt. - rare; one specimen found on moist seismic line; OS

Carex brunnescens (Pers.) Poir. - occasional; occurs along streambanks, mesic mixedwoods in wetter areas, wet seismic lines and open Picea peatlands; matures in mid July; 2S

Carex canescens L. - widespread; in a variety of wet habitats - tops of beaver dams, Salix - Picea swamps, poor fens, pond margins; can be locally abundant, flowers in June; var. subloliacea Laest. also occurs in the region; 12S

1 Carex chordorrhiza L.f. - uncommon; found in patterned fens and open wet Picea mariana - Larix laricina peatlands; probably more common than noted in stand relevés; 1S

Carex crawfordii Fern. - occasional; aquatic emergent along pond margins, streamsides and lakeshores; flowers in late July; 3S

Carex diandra Schrank - common; aquatic emergent found in wetter habitats - beaver dams, wet meadows, wet Salix - Betula poor fens, ponds and lakeshore marshes; flowers in early July; 3S

Carex disperma Dewey - common; usually in moist eutrophic habitats, streamsides and wet depressions in mature Picea or mixedwood forests, lakeshores, hummocks in Salix swamps; flowers in June; 10S

Carex foenea Willd. - common; oligotrophic, sandy, open Pinus forest uplands and dry disturbed sites; flowers in late June; 4S

Carex lasiocarpa Ehrh. var. americana Fern. - rare; found once in peaty marsh; 0S

Carex limosa L. - widespread and abundant; often co-dominant with ericaceous shrubs, C. aquatilis and Scheuchzeria palustris in poor fens, tends to grow in wetter microhabitats, open Picea mariana peatlands; flowers by late June; 11S

1 Carex loliacea L. - rare; one occurrence along moist streamside in mature forest; Packer and Bradley (1984) note it as rare in Alberta; 0S

Carex media R. Br. - common; moist streamsides, hummocks in Salix swamps, sandy lakeshores; flowers in late June; 3S

Carex paupercula Michx. - uncommon; open Picea peatlands; probably more common; 0S

Carex prairea Dewey - common and locally abundant; tops of beaver dams, tufted Carex fens, wet streamside marshes; flowers in early June; 2S

Carex praticola Rydb. - occasional; dry upland sites, disturbed sandy locales, open Pinus forests, upland old burn, rarely in moist mixedwood; flowers in early July; 2S

Carex rostrata Stokes - widespread; often co-dominant with C. aquatilis in marshes, found in a variety of nutrient regimes - lake, pond and stream margins, Alnus and Salix thickets, poor fens, depressions in upland forests, occasional in open Picea peatlands; matures by mid July; 11S

Carex sartwellii Dewey - rare; tentatively identified from one location - wet meadow; 0S

1 Carex scoparia Schk. - rare; tentative identification; moist top of beaver dam; considered rare in Alberta by Parker and Bradley (1984); 0S

Carex tenuiflora Wahlenb. - uncommon; moist Salix thickets, open Picea - Larix peatlands, wet area within burn; flowers in early July; 2S

1 Carex trisperma Dewey - rare; poor fen; considered rare in Alberta by Packer and Bradley (1984) and Argus and White (1978); 1S

Carex vaginata Tausch - occasional; mixedwoods in wetter microhabitats, drier Salix swamps, edge of Carex fens, mesic feathermoss forests; flowers by mid June; 2S

1 Carex vesicaria L. - common; sometimes co-dominant in poor fens, wetter areas in open Picea peatlands, occasionally in ericaceous - Sphagnum fens; flowers by early July; considered rare in Alberta by Packer and Bradley (1984); 5S

Eleocharis palustris (L.) R. & S. - occasional; aquatic emergent in beaver ponds, lake margins; 1S

Eriophorum angustifolium Honckeny - occasional; wet more oligotrophic sites, flarks in patterned fen, poor fens, Carex - Sphagnum marshes; 2S

Eriophorum brachyantherum Trautv. - uncommon; wet openings in Picea mariana forests, moist Salix thickets in burned area; 1S

Eriophorum gracile Koch. - rare; one occurrence in a wet poor fen, could be more common than indicated; 1S

Eriophorum vaginatum L. ssp. spissum (Fern.) Hulten - widespread; wet open Picea peatlands, co-dominant in ericaceous shrub - Sphagnum communities, poor fens; 8S

Eriophorum viridi-carinatum (Engelm.) Fern. - common; wet habitats - poor fens, open Picea - Larix peatlands, Salix - Betula thickets; 5S

Scirpus atrocinctus Fern. - uncommon; one specimen collected on moist seismic line; flowers in late July; 0S

1 Scirpus atrovirens Willd. var. pallidus Britt. - rare; found in two locations - margin of beaver pond and wet herbaceous meadow; reported rare in Alberta by Packer and Bradley (1984), and considered rare in Alberta by Argus and White (1978); 0S

Scirpus microcarpus Presl. - common, aquatic emergent along lakeshores, Carex - Sphagnum wetlands, streamsides; flowers by late June; 2S

Scirpus validus Vahl - rare; one occurrence on sandy lakeshore site; 0S

ARACEAE

Calla palustris L. - occasional; aquatic emergent beaver dams, marsh margins, streamsides in slow moving water; flowers by late June; 1S

LEMNACEAE

Lemna minor L. - widespread and locally abundant; floating aquatic species, found in most places where water is ponded and quiet - beaver ponds, streams, lake margins; 7S

JUNCACEAE

Juncus balticus Willd. var. montanus Engelm. - rare; found once on moist sandy winter road, probably more common; OS

Juncus bufonius L. - uncommon; wet seismic lines; OS

1 Juncus filiformis L. - occasional; wet ground adjacent to marsh, moist forestry winter road and seismic lines; rare in Alberta according to Packer and Bradley (1984); OS

Luzula parviflora (Ehrh.) Desv. - common; Salix swamps, tops of beaver dams, moist seismic lines; 3S

LILIACEAE

Disporum trachycarpum (S. Wats.) B. & H. - occasional; moist Picea - Populus woods; flowers in early to mid June; 3S

Lilium philadelphicum L. var. andinum (Nutt.) Ker - uncommon; found in drier open Populus woods, disturbed sites along the forestry winter road and open dry south-facing slopes; flowers in early to mid July; 3S

Maianthemum canadense Desf. var. interius Fern. - widespread; can be locally dominant in herb strata, moist mixedwoods, mature Picea - Abies - feathermoss forests; flowers in late June - early July; 26S

Smilacina trifolia (L.) Desf. - common; Alnus and Salix thickets, often dominant on Sphagnum hummocks within peatlands, found in a variety of moisture conditions; flowers in late June - early July; 18S

2 Streptopus amplexifolius (L.) DC. - reported by Achuff 1974.

ORCHIDACEAE

Calypso bulbosa (L.) Oakes - uncommon; recorded once in mesic Picea - Populus tremuloides - feathermoss forest, may occur more widely in similar habitats; flowers in early June; OS

Corallorhiza trifida Châtelain - uncommon; moist mixedwood and Picea - Abies - feathermoss forests; flowers in mid to late June; 1S

Goodyera repens (L.) R. Br. - uncommon; mesic mixedwood forests; 2S

Habenaria hyperborea (L.) R. Br. - common; wet to mesic habitats, wet herbaceous openings in coniferous forests, mossy Salix and Alnus thickets, wet meadows, seismic lines and winter road; flowers in July; 4S

Habenaria orbiculata (Pursh) Torr. - rare; found once in mature mixedwood forest; 1S

Listera cordata (L.) R. Br. - uncommon; wet herbaceous opening in coniferous forests, mesic Picea forests; flowers in mid July; 1S

Spiranthes romanzoffiana Cham. & Schl. - common; disturbed moist sites - seismic lines and forestry winter road, also Picea mariana peatlands; flowers in mid to late July; 1S

SALICACEAE

Populus balsamifera L. - occasional; usually occurring as a subdominant canopy species in mesic Populus tremuloides and mixedwood stands, occasionally forms small pure stands or is co-dominant with P. tremuloides on north- or east-facing slopes; 9S

Populus tremuloides Michx. - widespread; dominant deciduous canopy species; forms pure stands on well drained to mesic uplands or is co-dominant with Picea, Pinus or Betula ssp.; 30S

Salix arbusculoides Anderss. - occasional; margins of Carex fens, mesic Salix - herb thickets, moist streamsides; 2S

Salix bebbiana Sarg. - widespread; dry Pinus forests, wet Alnus thickets, Picea mariana - feathermoss forests, streamsides, lakeshores, disturbed sites, mesic mixedwoods, dry open slopes; forms small pure upland stands 8+ metres tall, grows to a variety of heights; 20S

Salix candida Fluegge - uncommon; margins of Carex marsh, lakeshores; var. denudata Anderss. is also reported; 0S

Salix discolor Muhl. - uncommon; one stand noted along forestry winter road in mesic mixedwood, Alnus thickets; 1S

Salix glauca L. - rare; found once in moist opening in Picea mariana forest; 0S

Salix myrtillifolia Anderss. - widespread; most common Salix under 0.5 m tall; dominant in moist Picea mariana stands, herbaceous openings in coniferous forests, streamsides, marsh margins, found in combination with S. planifolia in thickets; uncommon in mesic Populus tremuloides stands; 8S

Salix pedicellaris Pursh var. hypoglauca Fern. - common; co-dominant in poor fens; occasional in open Picea peatlands, moist streamsides, Salix swamps, marshes; 10S

Salix planifolia Pursh - widespread; often abundant; dominant tall shrub of lowland Salix swamps, often forming pure stands; wet meadows, streamsides, lakeshores, upland depressions, uncommon in mesic mixedwoods; 10S

Salix pseudomonticola Ball. - rare; sandy lakeshore, one tentative identification from upland Pinus - Picea forest; 1S

Salix pyrifolia Anderss. - common; Salix thickets in upland depressions, streamside swamps, lakeshores, occasionally in Picea mariana - feathermoss forests, wet fens; 10S

Salix scouleriana Barratt - occasional; habitat similar to S. bebbiana, can grow to 6+ metres, mesic Populus tremuloides, Pinus and mixedwood forests; 5S

Salix serissima (Bailey) Fern. - uncommon; Picea - Larix - Salix thickets, edge of shore marshes; 1S

BETULACEAE

Alnus crispa (Ait.) Pursh - widespread, occasionally abundant; dominant tall shrub of well drained upland forests, open Pinus woodlands, mesic Populus tremuloides and mixedwoods; 10S

Alnus tenuifolia Nutt. - common, locally abundant; often forming dense thickets along streams, lakeshores, Salix - Carex swamps, can reach 6+ metres in height; 8S

2 Betula glandulosa Michx. - reported by Lee, Gilmore and McIsaac 1979

Betula papyrifera Marsh. - widespread; mesic upland forests, often major second canopy species, occasionally co-dominant with Picea glauca or forming pure stands; a stunted form is present in drier areas of poor fens, Salix swamps; 31S

Betula pumila L. var. glandulifera Regel - widespread and abundant; wet habitats, co-dominant with ericaceous shrubs or Salix in poor fens, peatlands and swamps; 12S

URTICACEAE

Urtica gracilis Ait. - widespread; wet habitats, moist shaded mossy streambanks, lakeshores, beaver dams, pond margins; flowers in early July; 3S

SANTALACEAE

Geocaulon lividum (Richards.) Fern. - common; upland forests, mossy mesic coniferous or mixedwood forests, occasional in xeric Pinus forests; flowers in mid June; 9S

POLYGONACEAE

Polygonum amphibium L. var. stipulaceum (Coleman) Fern. forma fluitans (Eat.) - widespread; aquatic emergent; muddy substrates along pond and lake margins, stream marshes, tops of beaver dams; flowers in late July; 5S

Polygonum lapathifolium L. - rare; one stand recorded on margin of beaver pond; 0S

Rumex occidentalis S. Wats. - common although never dominant; wet habitats, lakeshores, pond margins, Carex marshes, wet meadows, beaver dams, streamsides; 6S

CARYOPHYLLACEAE

Arenaria dawsonensis Britt. - occasional; moist shaded Alnus dominated streamsides, hummocks in Salix swamps, moist Populus tremuloides stands, mature mossy Picea woods; flowers in mid to late June; 2S

Arenaria lateriflora L. - common; similar habitats as A. dawsonensis; flowers later, early to mid July; 4S

Stellaria crassifolia Ehrh. - uncommon; eutrophic moist locations, shaded streamsides, lakeshores; flowers by mid July; 0S

Stellaria longifolia Muhl. - widespread; wet habitats - Alnus and Salix thickets, lakeshore and pond margins, beaver dams, moist locations in coniferous forests, Carex marshes; flowers in late June to late July; 11S

Stellaria longipes Goldie - common; lake and pond margins, beaver dams, Salix thickets, upland depressions; flowers in July; 0S

NYMPHAECEAE

Nuphar variegatum Engelm. - occasional; floating aquatic species; shallow calm water of wider stream channels, sheltered sites in ponds and lakes; 0S

CERATOPHYLLACEAE

Ceratophyllum demersum L. - common; ponds, larger quiet stream channels, shallow water in lakes; can form large patches; 0S

RANUNCULACEAE

Actaea rubra (Ait.) Willd. - common; dry to mesic upland forests, open Pinus woodlands, Populus tremuloides stands, Picea glauca - feathermoss sites; flowers in early to mid June; 14S

Aquilegia brevistyla Hook. - rare; moist streamsides, one collection from seismic line; flowers in early July; 0S

Caltha natans Pall. - occasional; semi-aquatic to aquatic habitats - ponds, slow moving streams; flowers mid June to late July; 0S

Caltha palustris L. - widespread, locally dominant; wet streamsides, Alnus and Willow thickets, shallower water in Carex marshes, lakeshores, flooded lands; flowers in late May to late June; 11S

Coptis trifolia (L.) Salisb. - rare; recorded once in mesic mossy Betula - Picea - Abies stand; flowers in mid June; 1S

Delphinium glaucum S. Wats. - occasional; damp herbaceous woodlands, moist streamsides, Alnus - Salix thickets; flowers in July; 3S

Ranunculus abortivus L. var. acrolasius Fern. - uncommon; moist mixedwoods; flowers in early July; 0S

Ranunculus circinatus Sibth. var. subrigidus (W. Drew) L. Benson - occasional, locally abundant; wet mud flats, stream margins, Carex fens and marshes; forms extensive mats in shallow water; flowers in early July; 0S

Ranunculus gmelinii DC. - occasional; aquatic and semi-aquatic habitats - beaver ponds, Salix swamps, shore marshes, streams, mud flats; flowers in June; 1S

Ranunculus lapponicus L. - occasional; shallow standing water, wet Salix - Picea swamps, mesic Picea peatlands; flowers in June; 2S

Ranunculus macounii Britt. - uncommon; moist woods, beaver dams; 0S

Ranunculus pensylvanicus L.f. - occasional; pond shorelines, one collection from mud flats adjacent to beaver ponds; flowers in early July; 1S

Ranunculus sceleratus L. - uncommon; beaver dams, pond margins; 0S

Thalictrum sparsiflorum Turcz. var. richardsonii (Gray) Boivin - common; moist mixedwoods, damp herbaceous thickets, especially along streamsides; flowers in early July; 4S

FUMARIACEAE

Corydalis aurea Willd. - rare; one specimen recorded from top of beaver dam; could be more common; 0S

CRUCIFERAE

Cardamine pensylvanica Muhl. - occasional; wet sandy lakeshores, moist Salix stands, tops of beaver dams, pond margins; flowers in early to mid June; 0S

Erysimum cheiranthoides L. - occasional; moist Salix sites, mesic mixedwoods; flowers in July; 1S

Rorippa islandica (Oeder) Borbas - occasional; wet streamsides and lakeshores, tops of beaver dams, moist disturbed sites; var. fernaldiana Butters and Abbe and var. hispida (Desv.) Butters and Abbe are represented in the region; flowers in early July; 1S

DROSERACEAE

Drosera rotundifolia L. - occasional; Sphagnum hummocks in Picea peatlands, poor fens; 4S

SAXIFRAGACEAE

Chrysosplenium iowense Rydb. - common, can be fairly abundant; low moist habitats, mossy stream banks, lakeshores, Salix - Carex communities, Alnus thickets, tops of beaver dams; flowers in early to mid June; 5S

Mitella nuda L. - widespread; moist mixedwoods, mature Picea - Abies stands; flowers in mid June to early July; 17S

Parnassia palustris L. var. neogaea Fern. - occasional; wet poor Carex fens, moist open disturbed sites, mossy streamsides; flowers in late July; 2S

Ribes glandulosum Grauer - common; wet streamsides, Alnus - Salix thickets, mesic Populus tremuloides stands; flowers in early June; 4S

Ribes hirtellum Michx. - commmon; moist shrubby thickets, mesic Populus stands; 8S

Ribes hudsonianum Richards. - common; streamsides, moist woods; flowers in June; 7S

Ribes lacustre (Pers.) Poir - uncommon; wet Salix - herb communities, moist mixedwoods; may be more common than noted; 2S

Ribes oxyacanthoides L. - occasional; wet thickets, lakeshores, streamsides, Salix stands; flowers in mid June; 4S

Ribes triste Pall. - uncommon; moist streamsides, Salix thickets, lakeshores in Alnus stands; flowers in mid June; 1S

ROSACEAE

Amelanchier alnifolia Nutt. - common, occasionally abundant; open mixedwoods, mesic Populus forests, dry open south-facing slopes, usually under two metres tall; flowers in early to mid June; 8S

2 Fragaria vesca L. - reported by Ellis, Doherty and La Roi 1978 and Laidlaw and Hnatiuk 1969

Fragaria virginiana Duchesne var. glauca S. Wats. - common; open woods in mesic to subxeric habitats, open slopes, Populus stands, along forestry winter road and in disturbed sites; flowers in June; 7S

Geum allepicum Jacq. var. strictum (Ait.) Fern. - uncommon; mesic Populus tremuloides woods; 1S

Geum macrophyllum Willd. - common; wet herbaceous meadows, streamsides, Salix - Alnus thickets, pond edges; var. perincisum (Rydb.) Raup also occurs; flowers in July; 8S

Potentilla norvegica L. - occasional; wet to moist habitats - Alnus stands, Salix thickets, wet meadows, lakeshores, marshes, tops of beaver dams, disturbed sites; flowers in late June and July; 3S

Potentilla palustris (L.) Scop. - common, occasionally abundant; poor fens, Salix flats, wet Alnus thickets, Carex marshes; flowers in July; 12S

Potentilla rivalis Nutt. - uncommon; edges of sandy pondshores, seismic lines in low areas; flowers in late July; 0S

Potentilla tridentata Ait. - widespread, sometimes abundant; sandy soil in mesic to xeric habitats, open Pinus forests, disturbed sandy sites; flowers in late June and July; 4S

Prunus pensylvanica L.f - uncommon; open Populus woodlands; flowers in mid June; 2S

Rosa acicularis Lindl. - widespread, often dominant; variety of nutrient regimes in subxeric to subhygric habitats - open Pinus woodlands, mixedwoods, Populus, mature Picea glauca - feathermoss communities, open slopes, upland Picea mariana forests; flowers in late June, early July; 38S

Rubus acaulis Michx. - common; low moist ground, Picea mariana peatlands, streamsides, moist woods; flowers in early June up to early July; 10S

Rubus chamaemorus L. - widespread, can be locally abundant; co-dominant forb with Smilacina in closed and open Picea mariana peatlands; can dominate on drier peat hummocks; flowers in mid to late June; 12S

Rubus pubescens Raf. - widespread; moist mature feathermoss forests, Picea - Abies stands, moist mixedwoods, wet Alnus thickets; flowers from early to late June; 16S

Rubus strigosus Michx. - widespread; mesic mature mixedwoods, Populus tremuloides stands, dry open Pinus forests, herbaceous thickets; in flower during late June - early July; 14S

LEGUMINOSAE

Astragalus frigidus (L.) A. Gray var. americanus (Hook.) S. Wats - rare; one specimen located on moist open slope; flowers in July; 0S

Lathyrus ochroleucus Hook. - common; eutrophic, subhygric to submesic habitats, open Populus tremuloides and mixedwood forests, herbaceous thickets; flowers in early July; 13S

2 Lathyrus venosus Muhl. var. intonsus Butters and St. John - reported by Lee, Gilmore and McIsaac 1979

Trifolium repens L. - uncommon; open disturbed mesic sites, along forestry winter road; probable exotic species; flowers in late June - early July; 0S

Vicia americana Muhl. - common, often dominant forb; mesic rich Populus tremuloides forests, mixedwoods, drier open slopes; flowers in late June and July; 11S

GERANIACEAE

Geranium bicknellii Britt. - occasional; moist Picea - Populus tremuloides forests; 2S

BALSAMINACEAE

Impatiens noli-tangere L. - uncommon; moist locations, tops of beaver dams, shady mixedwoods, lakeshores and streamsides, herbaceous thickets; flowers later in July; 0S

VIOLACEAE

Viola adunca J. E. Smith - occasional; moist open woodlands, Populus tremuloides forests, open slopes; blossoms in early to mid June; 1S

Viola palustris L. - widespread; moist shady places, streamsides, Salix and Alnus thickets, moist woods; flowers by mid June; 8S

2 Viola renifolia A. Gray - reported by Ellis, Doherty and La Roi 1978 and Achuff 1974.

Viola rugulosa Greene - common, can be locally abundant; rich Populus tremuloides - Picea glauca forests, P. tremuloides stands, drier hummocks in Salix swamps, more mesic Pinus forests; blossoms from mid June up to late July; 6S

ELAEAGNACEAE

Shepherdia canadensis (L.) Nutt. - uncommon, never abundant; open Pinus - Populus tremuloides woodlands, open slopes; flowers in early June; 2S

ONAGRACEAE

Circaea alpina L. - uncommon; tends to grow in patches; moist mossy coniferous forests; flowers in early July; 3S

Epilobium angustifolium L. - widespread; in a variety of nutrient and moisture regimes, dominant in open disturbed sites, present but more suppressed in submesic to mesic Populus tremuloides and mixedwood forests, occasional in feathermoss forests, hummocks in Alnus thickets, open slopes; flowers in July and August; 28S

Epilobium glandulosum Lehm. - common; moist to wet habitats, streambanks, wet herbaceous meadows, pond sides, lakeshores, tops of beaver dams; flowering in July; 4S

Epilobium leptophyllum Raf. - occasional; wet open Salix flats, lakeshore marshes, open streamsides, moist seismic lines; flowers in late July, 3S

Epilobium palustre L. - widespread; wet ground, peatlands, Alnus - Salix stands, ponds and lakeshores, wet herbaceous meadows, tops of beaver dams; flowers in July; 7S

HALORAGIDACEAE

Myriophyllum exalbescens Fern. - common and often abundant; shallow water habitats, areas in lakes, ponds, deep stream channels; can form dense mats; 0S

HIPPURIDACEAE

Hippuris vulgaris L. - common; ponds, shore marshes, pools in Salix - Carex swamps, muddy shorelines; 2S

ARALIACEAE

Aralia nudicaulis L. - widespread, often a dominant forb; mesic, more eutrophic habitats, rich woodlands, mesic mixedwoods, Betula - Abies feathermoss stands; blossoms in mid to late June; 13S

UMBELLIFERAE

Cicuta bulbifera L. - occasional; moist seismic lines, beaver dams, marshy places; 0S

Cicuta douglasii (DC.) Coult. & Rose - common; aquatic emergent along pond and lake shores, beaver dams, moist seismic lines; comes into flower in July; 9S

Osmorhiza depauperata Philippi - rare; one find from along the winter road in mesic woodlands; could be more common; 0S

Sium suave Walt. - common; wet Salix and Alnus swamps in standing water, open Carex marshes, margins of ponds and lakes; flowers in July; 4S

CORNACEAE

Cornus canadensis L. - widespread, often abundant; in a variety of habitats - rich mesic Populus tremuloides stands, mixedwood forests, coniferous feathermoss forests; prolific flowering mid June to the end of July; 43S

PYROLACEAE

Moneses uniflora (L.) A. Gray - occasional; damp shady locations - mature Picea - Abies stands, mixedwoods, mossy streambanks, Alnus thickets; flowers in July; 3S

Pyrola asarifolia Michx. - common; the dominant wintergreen species in the area; mesic mixedwood forests, Populus tremuloides stands, mature Picea - Abies feathermoss forests, Alnus thickets on hummocks; blossoms in July; 15S

Pyrola secunda L. - common; habitat similar to P. asarifolia, mesic woodlands, mossy streambanks, drier poor fens; flowers mature in July; 14S

Pyrola virens Schweigg. - occasional; mesic mature forests, mixedwoods; flowers in early July; 4S

ERICACEAE

Andromeda polifolia L. - widespread, occasionally abundant; often co-dominant with Chamaedaphne in poor fens, dry Picea peatlands, flarks in the patterned fens; flowers in June; 8S

Arctostaphylos uva-ursi (L.) Spreng. - common, occasionally abundant; dry open Pinus woodlands, submesic open mixedwoods; flowers matured by late June; 11S

Chamaedaphne calyculata (L.) Moench - common and abundant; wet bog-like environments, poor fens, wet Picea peatlands, patterned fens; co-dominant with ericaceous shrubs; flowers by early June; 16S

Kalmia polifolia Wang. var. microphylla (Hook.) Rehd. - occasional, never dominant; wetter Picea peatlands, hummocks in Carex poor fen; flowers in mid to late June; 4S

Ledum groenlandicum Oeder - widespread, often abundant; dominant ericaceous shrub; mesic more oligotrophic habitats - open or closed Picea mariana - Sphagnum peatlands, moist Carex - Sphagnum communities, upland Picea mariana - feathermoss forests, occasional in mesic mixedwoods; blossoms in late June - early July; often co-dominant shrub with Vaccinium vitis-idaea; 39S

2 Ledum palustre L. var. decumbens Ait. - reported by Lee, Gilmore and McIsaac 1979

Oxycoccus microcarpus Turcz. - widespread; mesic and dry Picea mariana peatlands on Sphagnum hummocks, more open areas in upland Picea mariana - feathermoss forests; flowers in late June - early July; 20S

Oxycoccus quadripetalus Gilib. - rare; only reported from one stand - wet poor fens on hummocks; may be more common; 1S

Vaccinium caespitosum Michx. - rare; one record from an old upland burn site; 1S

Vaccinium myrtilloides Michx. - widespread, often abundant; drier and more oligotrophic habitats - dry open Pinus forests, upland Picea - feathermoss forests, common but less abundant in mixedwood stands; flowers in mid June; often co-dominant with V. vitus-idaea; 30S

Vaccinium vitis-idaea L. var. minus Lodd. - widespread and abundant; oligotrophic sites in a variety of moisture regimes - upland Picea mariana - feathermoss stands, drier Picea peatlands, submesic mixedwoods, dry Pinus stands; blossoms in late June; 35S

PRIMULACEAE

Lysimachia thyrsiflora L. - occasional, sometimes locally abundant; shallow water, lakeshores, Alnus thickets, wet meadows, moist seismic lines; flowers in July; 2S

Trientalis borealis Raf. - common, but never abundant; mesic upland forests, Pinus forests, mixedwoods; blossoms in June; 14S

Trientalis europaea L. var. arctica (Fisch.) Ledeb. - uncommon; mesic Betula - Abies - feathermoss forests, wet Alnus thickets, moist Populus tremuloides woods, mixedwood forests; blossoms in late June; 1S

GENTIANACEAE

Gentianella amarella (L.) Borner ssp. acuta (Michx.) J. M. Gillett - rare; one specimen collected in disturbed moist soil near the highway; may be an exotic species; OS

Halenia deflexa (Sm.) Griseb. - uncommon; moist mixedwoods, mesic seismic lines; flowers in July; OS

Menyanthes trifoliata L. - occasional; in shallow water - at waters edge in floating Sphagnum - Carex fens, patterned fen, poor fens; flowers in June; 3S

BORAGINACEAE

Mertensia paniculata (Ait.) G. Don - widespread; dominant forb; mesic herbaceous upland Populus tremuloides stands, mesic Picea - Abies - feathermoss forests, mixedwoods, open dry slopes, roadsides; flowers from early June to early July; 21S

LABIATAE

Mentha arvensis L. var. villosa (Benth.) S. R. Stewart - common, often locally abundant; moist lakeshores, wet streamsides and pond margins, tops of beaver dams; flowers in July; 2S

Scutellaria galericulata L. - common; low wet ground, muddy pond margins, moist lakeshores, Carex marshes, wetter openings in Salix swamps; flowers in July; 4S

SCROPHULARIACEAE

Castilleja miniata Dougl. - rare; along open dry winter road; OS

Melampyrum lineare Desr. - occasional; dry, more open sandy sites, submesic Pinus and Populus tremuloides woods, dry seismic lines; flowers in late July; 4S

Pedicularis labradorica Wirsing - common; boggy Picea mariana forests, occasional in mesic mixedwoods, mesic to submesic Pinus stands, wet sandy areas in disturbed sites, coniferous feathermoss stands, uncommon along moist streamsides; flowers from late June to late July; 7S

1 Pedicularis parviflora Smith - uncommon; wet Picea peatlands, moist seismic lines; flowers in July; considered rare in Alberta by Argus and White (1978); OS

Veronica americana (Raf.) Schw. - occasional; moist lakeshores, shallow water, pond and stream margins; blossoms in July; OS

Veronica scutellata L. - uncommon; muddy pond shores and other wet places; flowers in late July; OS

LENTIBULARIACEAE

Utricularia intermedia Hayne - rare; shallow water along pondsides; OS

Utricularia minor L. - common; shallow calm water habitats - streamsides, lakeshore marshes, pond margins, often in mud substrates; 4S

PLANTAGINACEAE

Plantago eriopoda Torr. - rare; one specimen noted from wet ground along seismic line; possible exotic species for this area; OS

RUBIACEAE

Galium boreale L. - widespread; mesic upland mixedwoods and Populus tremuloides stands; 15S

Galium labradoricum Wieg. - common; wet boggy sites - pond and lake margins, wet meadows, hummocks in poor fens and Salix - Alnus thickets; flowers in July; 5S

Galium trifidum L. - common; wet places in more eutrophic locations - lakeshores, Carex marshes, wet meadows, streamsides, upland depressions, Salix swamps, pond margins; flowers in July; 7S

Galium triflorum Michx. - common, wet Alnus - Salix swamps, mesic coniferous - feathermoss forests, mesic Populus tremuloides stands; blossoms in July; 10S

CAPRIFOLIACEAE

Linnaea borealis L. var. americana (Forbes) Rehd. - widespread, often abundant; submesic to mesic mixedwoods, moist Picea - Abies - feathermoss forests, mossy Pinus - Picea mariana stands; flowers in early to mid July; 32S

Lonicera dioica L. var. glaucescens (Rydb.) Butters - occasional; rich mesic Populus tremuloides stands; flowers in late June; 4S

Lonicera involucrata (Richards.) Banks - widespread; mesic to wet sites, more open areas in coniferous - feathermoss forests, mesic Populus tremuloides woods, Salix or Alnus thickets, streamsides; flowers in June; 14S

Symphoricarpos albus (L.) Blake - occasional; mesic mixedwoods, dry open slopes; flowers in early July; 6S

Viburnum edule (Michx.) Raf. - widespread and abundant; often the dominant shrub in open upland forests; mesic to submesic mixedwoods, open areas in Picea - Abies - feathermoss forests, Populus tremuloides stands; flowers in mid June; 25S

ADOXACEAE

Adoxa moschatellina L. - occasional; mossy streamsides and lakeshores; flowers in mid June; 6S

VALERIANACEAE

Valeriana septentrionalis Rydb. - rare; moist Salix stands; 0S

CAMPANULACEAE

Campanula rotundifolia L. - common; dry open slopes, open Populus tremuloides woods, subxeric to submesic Pinus forests, dry disturbed sites; flowers in July; 7S

COMPOSITAE

Achillea millefolium L. ssp. lanulosa (Nutt.) Piper - common; a variety of habitats, moist streamside thickets, Alnus and Salix thickets, open Populus tremuloides and mixedwood stands, disturbed locations; flowers in early to mid July; 9S

Antennaria concolor Piper - rare; one sighting along a dry seismic line in old burn location; flowers in late July; 0S

Antennaria neglecta Greene - uncommon; dry open slopes, dry disturbed sites such as the forestry winter road in sandy locations; flowers in June; 1S

Antennaria nitida Greene - rare; dry open sites, along forestry winter road in Pinus woods; flowers in late July; OS

Antennaria rosea Greene - rare; dry upland sandy areas; flowers in mid July; OS

Arnica cordifolia Hook. - occasional; rich herbaceous mixedwoods and Populus tremuloides stands; flowers in late June - early July; 3S

Artemisia campestris L. - rare; found in one site along mesic forestry winter road; flowers in late July; OS

Aster ciliolatus Lindl. - occasional; variety of upland forests - mesic Populus tremuloides forests, mixedwoods, submesic Pinus stands; flowers later in July; 5S

Aster conspicuus Lindl. - occasional; open woodlands; flowers in mid to late July; 5S

Aster foliaceus Lindl. - common; wet more eutrophic areas - lake margins, Salix streamside thickets, moist seismic lines; starts to flower in late July; 3S

Crepis tectorum L. - occasional; forestry winter road and seismic lines in mesic habitats; exotic species; flowers in July; OS

Erigeron strigosus Muhl. - uncommon; wet areas, streamsides, Salix thickets, forestry winter road and seismic lines; flowers in July; OS

Hieracium umbellatum L. - occasional; open south-facing slopes, open Pinus - Populus tremuloides forests, along forestry winter road or seismic lines in open dry woodlands; starts to flower in late July; 3S

Petasites palmatus (Ait.) A. Gray - widespread; mesic to subhygric upland forests and thickets, mixedwoods, Abies - Picea - feathermoss forests, herbaceous meadows; 26S

Petasites sagittatus (Pursh) A. Gray - common, can be locally abundant; wet mesotrophic to eutrophic habitats, Salix and Alnus thickets, streamsides, wet herbaceous meadows, upland depressions; flowers in late May and early June; 5S

Senecio congestus (R. Br.) BC. - rare; one specimen located in wet sand along Crow Lake; OS

Senecio indecorus Greene - rare; only noted once in moist sand on the forestry winter road; flowers in July, OS

Senecio pauperculus Michx. - occasional; moist habitats and disturbed places, drier Salix - Carex thickets, Salix stands in burned over area, moist forestry winter road and seismic lines, wet herbaceous meadows; flowers in July; 4S

Solidago decumbens Greene - uncommon; open Pinus and Picea woods; 3S

Taraxacum officinale Weber - uncommon; forestry winter road and disturbed sites, rarely in mixedwood forests; flowers in June; 0S

NOTE: Species constancy (how often a species is found throughout the study area) is described using the following qualitative scale:

rare:	found once in the study area
uncommon:	found in a few locations
occasional:	intermittently distributed
common:	often found in suitable habitats
widespread:	usually occurring in suitable habitats
abundant:	a dominant species where it occurs
locally abundant:	forms extensive patches in some locations (used in conjunction with above descriptions)

This scale is used to describe species occurrences in relation to the study area. Those species that are considered rare or uncommon in a provincial context are designated by the number 1.

Those species found in the study area by previous researchers, but not located during the 1983 field season, are designated by the number 2.

After each species' habitat description is a number followed by an 'S' (eg. 0S, 4S). This indicates the number of relevé stands (out of 76 sampled) in which that species was found.

Appendix 8.2

ANNOTATED LIST OF MOSSES AND LIVERWORTS

Anastrophyllum helleranum (Nees) Schust. - liverwort; uncommon; shady mixedwood stands on bark

Aulacomnium palustre (Hedw.) Schwaeger. - common, occasionally abundant; on a variety of substrates, usually in wetter locations - wet herbaceous meadows, margins of marshes, dominant in upland Salix thickets, poor fens, burned over peatlands, wetter Salix thickets in Picea woods; 18S

Brachythecium salebrosum (Web. and Mohr.) B.S.G. - occasional; drier sites - shaded soil in mixedwoods, on stones, logs and bases of trees in mixedwoods, Populus tremuloides forests, and Alnus and Salix thickets; 5S

Brachythecium turgidum (C. J. Hartm.) Kindb. - uncommon; wet soils or humus, Salix thickets, Carex marshes in drier sites; 2S

Bryum pseudotriquetrum (Hedw.) Gaertn., Meyer and Scherb. - occasional; wet habitats, Salix swamps, wetter areas in upland peatlands; 3S

Calliergon cordifolium (Hedw.) kindb. - occasional, locally abundant; wet herbaceous meadows, upland streamsides; 1S

Calliergon giganteum (Schimp.) Kindb. - common; submerged or emergent species in shallow water, Salix and Alnus swamps, wetter areas in Picea mariana peatlands, poor fens, Carex marshes; 4S

Calliergon stramineum (Brid.) Kindb. - occasional; shallow pools or damp depressions in poor fens, burned over sites, Carex depressions; 3S

Campylium radicale (P. Beauv.) Grout - uncommon, can be abundant; wet Carex marshes on humus and decaying material; may be more common than noted; 1S

Ceratodon purpureus (Hedw.) Brid. - frequent; on logs or rocks - sandy winter road, burned over ground, Pinus and upland Picea mariana forests, Salix swamps and upland forests, dry disturbed sites; 6S

Climacium dendroides (Hedw.) Web. & Mohr. - common, can be quite abundant; wet, shady more eutrophic sites - upland Salix bebbiana thickets, Alnus and Salix swamps, streamsides, wet herbaceous meadows, rare in mesic Picea forests; 7S

Conocephalum conicum (L.) Lindb. - liverwort; uncommon; moist Alnus and Salix swamps on hummocks and in depressions; 1S

Dicranum acutifolium (Lindb. & H. Arnell) C. Jens. ex Weinm. - rare, one location noted; Picea mariana - Pinus - feathermoss forest; may be more common; 1S

Dicranum flagellare Hedw. - rare; on rotten logs and stumps - upland Populus ssp. forests; perhaps more common than noted; 1S

Dicranum fragilifolium Lindb. - uncommon; upland forest habitats, Picea mariana - feathermoss forests, shady mixedwood stands; 2S

Dicranum fuscescens Turn. - occasional; usually on logs or stumps - Picea - feathermoss forests, streamsides, mixedwoods; 3S

Dicranum polysetum Sw. - widespread, can be locally abundant; often intermixed with feathermosses; shady submesic to mesic upland forests, mixedwoods, coniferous forests, Pinus stands, occasionally in Picea peatlands, largest and most common Dirranum species; 19S

Dicranum undulatum Brid. - common; variable habitats - Sphagnum hummocks in dry Picea mariana peatlands, mixedwoods, Populus tremuloides and Pinus stands, coniferous feathermoss forests, moist streamsides; often on rotten logs; 16S

Drepanocladus aduncus (Hedw.) Warnst. - occasional, usually abundant where present; wet mesotrophic habitats, usually emergent or submerged - margins of ponds, poor fens, wet Carex marshes, probably more common than noted; 2S

Drepanocladus exannulatus (B.S.G.) Warnst. - uncommon; dominant in wet Salix swamps, also found submerged in wettest flarks in patterned fen, may be more common than indicated; 1S

Drepanocladus fluitans (Hedw.) Warnst. - uncommon, open Picea - Larix poor fens; 1S

Drepanocladus lapponicus (Norrl.) Smirn. - uncommon; wet Salix depression in Picea mariana forests; 1S

Drepanocladus sendtneri (Schimp.) Warnst. - rare; sandy shores, beaver ponds; 0S

Drepanocladus uncinatus (Hedw.) Warnst. - common; moist coniferous forests, mixedwoods, Alnus streamsides, wet Salix swamps, pond shores; often grows in more eutrophic habitats; 5S

Eurhynchium pulchellum (Hedw.) Jenn. - occasional; on soil, humus substrates, rotten logs and stumps, moist mixedwoods and coniferous forests; 4S

Helodium blandowii (Web. & Mohr) Warnst. - rare; upland Salix stands; 1S

Hylocomium splendens (Hedw.) B.S.G. - widespread; cool shady coniferous forests, less common mixedwood forests, upland Salix stands; frequently co-dominant with other feathermosses; 28S

Mnium medium B.S.G. - reported by Achuff 1974 (referred to as Plagiomnium medium)

Hypnum pratense Koch ex. Brid. - rare; wet areas in Picea mariana forest; a calciphile species; 0S

Jamesoniella autumnalis (D. C.) Steph. - liverwort; occasional; on logs - cool shady feathermoss forests, mesic mixedwoods; 4S

Marchantia polymorpha L. - liverwort; common, can be locally abundant; moist or semiaquatic habitats - Salix and Alnus thickets, upland depressions, moist pondshores, muddy shorelines and streamsides, less common in mesic shady forests; 3S

Mnium spinulosum B.S.G. - rare; one record from mature mixedwood forest; 1S

Mylia anomala (Hook.) S. Gray - liverwort; occasional; grows with Dicranum undulatum on hummocks in drier peatlands; 4S

Oncophorus Wahlenbergii Brid. - occasional; on rotten logs in moist mixedwood and Populus tremuloides forests; 3S

Orthotrichum speciosum Nees ex. Sturm. var. elegans (Schwaegr. ex Hook. & Grev.) Warnst. - rare; one record from logs in moist meadow; 1S

Plagiochila asplenioides (L.) Dum. - liverwort; rare; wetter areas in Picea mariana forests; 0S

Plagiomnium cuspidatum (Hedw.) Kop. - common; upland mixedwoods and Populus tremuloides forests on logs, Alnus - Salix swamps on hummocks; 7S

Plagiomnium drummondii (Bruch & Schimp.) Kop. - uncommon; on logs in upland mixedwood stands; 1S

Plagiomnium ellipticum (Brid.) Kop. - widespread,can be abundant; wet Salix swamps, Alnus thickets, wet herbaceous meadows, fens and marsh communities, wetter areas in upland forests on moist rotten logs; 10S

Platygyrium repens (Brid.) B.S.G. - uncommon; on logs and tree trunks in moist Populus tremuloides - P. balsamifera stands; 1S

Pleurozeum schreberi (Brid.) Mitt. - widespread and abundant; on humus and soil in a variety of habitats - shady coniferous forests and mixedwoods, submesic open Pinus forests, less widespread in Populus tremuloides stands; most common and dominant feathermoss; 48S

Pohlia nutans (Hedw.) Lindb. - common; on decaying logs and stumps in upland forests, Sphagnum hummocks in wet peatlands, strings in patterned fen, poor fens; colonizes disturbed sites such as along the forestry winter road and in moister burned areas; 6S

Polytrichum commune Hedw. - common; variety of mesic habitats - drier Picea mariana peatlands on hummocks, mossy coniferous forests, on logs in mixedwoods, streamsides; 12S

Polytrichum juniperinum Hedw. - common; on bare soil in semi-shady or open locations, coniferous forests and mixedwoods, occasionally found on logs and stumps; 7S

Polytrichum piliferum Hedw. - uncommon, can be locally abundant; open, sandy Pinus banksiana stands and other dry exposed places on more acidic substrates, occasional along forestry winter road; 2S

Polytrichum strictum Brid. - common; various habitats - hummocks in poor fens and open Picea peatlands, Salix swamps, moist streamsides, mixedwoods, coniferous stands; colonizes burned over areas; most widespread Polytrichum species; 14S

Pseudoleskeella sp. Kindb. - rare; one record from mossy Betula - Abies stand; 1S

Ptilidium ciliare (L.) Hampe. - liverwort; occasional; in coniferous forests; usually occurs with feathermosses; may be more common than noted; 2S

Ptilidium pulcherrimum (G. Web) Hampe. - liverwort; occasional; on logs in mature moist mixedwoods, Alnus thickets; 3S

Ptilium crista-castrensis (Hedw.) De Not. - widespread; variety of habitats although most abundant in shady coniferous forests, mature mixedwoods and along streamsides; similar in occurrence and dominance to Hylocomium splendens; 30S

Pylaisiella polyantha (Hedw.) Grout - uncommon; on tree bark in upland forests and Alnus thickets; 2S

Sphagnum angustifolium (C. Jens. ex Russ.) C. Jens in Tolf - widespread; hygric to mesic locations in a variety of nutrient regimes - poor fens, moist open Picea peatlands, patterned fens on flarks and smaller strings, streamsides, Carex depressions in upland forests, marsh edges, usually on sides of hummocks or in shallow troughs; widespread Sphagnum sp., often growing with Sphagnum magellanicum; 20S

Sphagnum fuscum (Schimp.) Klinggr - widespread, can be locally abundant; often caps hummocks in Alnus swamps, drier open Picea peatlands, less commonly on hummocks in shrubby poor fens, streamsides, wetter areas in coniferous forests, burned over peatlands; oligotrophic species; 17S

Sphagnum jensenii H. Lindb. - uncommon, locally abundant; wetter habitats, poor fens, more acidic Carex marshes, patterned fen on flarks; forms pure stands or is intermixed with Sphagnum majus; 2S

Sphagnum magellanicum Brid. - widespread; relatively oligotrophic sites - hummock sides in intermediate to wet moisture areas, open Picea peatlands, patterned fen on flarks and lower strings, poor Carex fens and marshes; 18S

Sphagnum majus (Russ.) C. Jens - uncommon, locally abundant; usually in more eutrophic habitats, submerged or emergent - patterned fen on flarks, Carex fens, slough margins; this species and Sphagnum jensenii may be more common than reported; can form pure populations; 2S

Sphagnum nemoreum Scop. - common, but not abundant; wet Salix swamps, troughs in open hummocky Picea peatlands, mossy coniferous forests, burned over dry peatlands, upland Salix thickets; 12S

Sphagnum obtusum Warnst. - rare; one record from Salix swamp; 1S

Sphagnum riparium Angstr. - rare, although locally abundant; one stand found along very wet margin of oligotrophic pond in Carex peatland community; 0S

Sphagnum russowii Warnst. - rare; wet Salix swamps on hummocks; 1S

Sphagnum sensustricta - rare; one record from poor fen; may be more common than reported; 1S
(This species is not listed in the nomenclature sources cited for the mosses.)

Sphagnum squarrosum Crome - occasional, can be abundant; eutrophic habitats, often submerged or in very wet areas - depressions in mature upland mixedwoods or coniferous forests, often dominant in Salix swamps; 1S

Sphagnum subsecundum Nees ex Sturm - uncommon; poor fen community; occurs with Sphagnum sensustricta; 1S

Sphagnum teres (Schimp.) Angstr. ex C. Hartm. - occasional; eutrophic, wetter habitats, sometimes semi-aquatic - edges of shore marshes, wet depressions in mature coniferous forests, can be dominant in Alnus and Salix swamps, less common in poor fens; 4S

Sphagnum warnstorfii Russ. - common; wet eutrophic habitats - margins of shore marshes, Salix swamps, can be abundant along stream courses and Salix - Betula shrubby fens, less common in upland Salix thickets; calciphile species; 8S

Splachnum sp. Hedw. - rare; on old moose dung, usually in boggy habitats; 1S

Tetraplodon angustatus (Hedw.) B.S.G. - occasional; usually on fecal substrates - coniferous forests; 3S

Tetraplodon mnioides (Hedw.) B.S.G. - uncommon; on dung substrates - Picea peatlands; 2S

Thuidium recognitum (Hedw.) Lindb. - rare; one record from upland Salix thicket on humus; reported to grow in a variety of habitats including woodlands, swamps and meadows, on a number of substrates; probably more common; 1S

Tomenthypnum falcifolium Ren. ex Nich. - rare; a sample was taken from an open Picea mariana peatland; probably more common; 1S

Tomenthypnum nitens (Hedw.) Loeske - common; wetter Betula - Salix poor fens, upland Salix thickets, streamside Salix - Alnus stands, wetter burned over areas, on hummocks in depressions in Picea peatlands, 7S

NOTE: For abundance codes and abbreviations, refer to NOTES at the end of the Annotated List of Vascular Plants.

Appendix 8.3

ANNOTATED LIST OF LICHENS

Cetraria ericetorum Opiz - uncommon; dry Picea mariana peatland, open Pinus forests; may be more common; 2S

Cetraria nivalis (L.) Ach. - common; drier peatlands, open Pinus forests, especially on sandy substrates; 7S

Cetraria pinastre (Scop.) S. Gray - reported by Lee, Gilmore and McIsaac 1979

Cladina alpestris (L.) Harm. - common; Picea mariana - Pinus - feathermoss stands, open Pinus forests; this species is also referred to as C. stellaris; 17S

Cladina mitis (Sandst.) Hale & W. Culb. - widespread, often abundant; dominant in open Pinus forests, drier Picea peatlands on hummocks, less abundant in Picea mariana and Pinus - feathermoss forests, uncommon in Populus tremuloides and mixedwood stands, open dry slopes; forms up to 80 percent ground on dry sandy substrates; 34S

Cladina rangiferina (L.) Harm. - common; upland drier Picea peatlands, Pinus forests; 14S

Cladonia cenotea (Ach.) Schaer - occasional; open Picea mariana peatlands, closed Picea - Pinus - feathermoss forests; 3S

Cladonia chlorophaea (Flörke ex Somm.) Spreng. - occasional; occurs on drier sites - open dry slopes, drier upland Picea peatlands, mixedwood forests on rotten logs; 4S

Cladonia coccifera (L.) Willd. - common; Picea mariana - Pinus - feathermoss forests, upland drier Picea peatlands, lowland peatlands on hummocks; 10S

Cladonia coniocraea (Flörke) Spreng. - uncommon; Picea - Pinus - feathermoss forests, Populus tremuloides stands on wood; 2S

Cladonia cornuta (L.) Hoffm. - common; Picea mariana - feathermoss forests, upland Picea peatlands, open Pinus stands, mixedwoods and Populus tremuloides woods on logs, lowland peatlands on hummocks; 17S

Cladonia cristatella Tuck. - occasional; dry Pinus forests, dry Picea peatlands, upland forests on logs; 3S

Cladonia fimbriata (L.) Fr. - occasional; dry peatlands, sandy Pinus forests, Picea - Pinus - feathermoss forests, mixedwoods on logs; 4S

Cladonia gonecha (Ach.) Asah. - common; dry hummocks in Picea peatlands, dry Pinus forests, Picea mariana - feathermoss forests, Populus woods on logs; one of the more abundant Cladonia species; 14S

Cladonia gracilis (L.) Willd. - common; drier, more oligotrophic habitats - Picea peatlands and open Pinus stands, less common in Pinus - Picea - feathermoss forests on logs in Populus tremuloides stands; 10S

Cladonia multiformis Merr. - occasional; dry open slopes, rotten logs in upland forests, Picea mariana - Pinus - forests, drier peatlands; 5S

Cladonia phyllophora Hoffm. - occasional; open Pinus forests, dry Picea mariana peatlands, Pinus - Picea - feathermoss forests; 4S

Cladonia uncialis (L.) Wigg. - occasional, sometimes locally abundant; open sandy Pinus forests, Picea - Pinus - feathermoss stands; grows in close association with C. mitis; may be more common than indicated; 4S

Dactylina arctica (Hook.) Nyl. - uncommon; mossy shady forests; 0S

Icmadophila ericetorum (L.) Zahlbr. - common; on dried out Sphagnum hummocks in Picea peatlands; 5S

Peltigera aphthosa (L.) Willd. - widespread; variety of moisture conditions - most common in Picea mariana and Pinus - feathermoss forests, also occurs in mixedwoods, hummocks in Alder - Salix swamps, dry Pinus forests; 36S

Peltigera canina (L.) Willd. - widespread; grows in many habitats with P. apthosa although tends to favor the drier sites - open Pinus forests, coniferous feathermoss stands; 32S

Peltigera malacea (Ach.) Funck. - rare; noted from only one stand - open Pinus forest; may be more common; 1S

Stereocaulon tomentosum Fr. - uncommon; dry habitats - open sandy Pinus forests, disturbed sites; 2S

Appendix 9

CONDENSED PHASE III FOREST INVENTORY DATA
ACCUMULATED AREA OF SIMILAR OVERSTORY FOREST
COVERS BY MAJOR SPECIES FOR THE CROW
LAKE STUDY AREA[1]

Map Cover	Stand Area (Hectares)[2]	Map Cover	Stand Area (Hectares)[2]	Map Cover	Stand Area (Hectares)[2]
A	1,474.2 (91)	DS	161.9 (12)	SbASw	33.3 (2)
AP	107.3 (12)	FbA	7.7 (1)	SbP	254.3 (15)
APSb	1.4 (1)	FL	24.2 (6)	SbSw	446.6 (28)
APSw	16.8 (1)	OM	742.4 (29)	Sw	330.1 (29)
ASb	18.8 (1)	P	1,409.5 (88)	SwA	745.7 (34)
ASbSw	12.3 (1)	PA	141.3 (11)	SwAP	49.7 (2)
ASw	878.3 (48)	PASb	4.8 (1)	SwFb	54.8 (2)
ASwP	26.8 (2)	PASw	17.6 (1)	SwP	27.7 (2)
ASwSb	20.2 (2)	PSb	217.7 (12)	SwPA	24.7 (1)
BU	247.7 (4)	PSw	81.5 (5)	SwSbA	2.7 (1)
Bw	10.4 (1)	PSwA	28.5 (1)	TM	470.5 (28)
CS	1,825.2 (114)	Sb	2,537.9 (138)	WA	630.2 (18)

NOTE: [1]Data compiled for TWPS 78-14-W4, 78-15-W4, 79-14-W4 all east of highway and south of sections 13-18 in TWP 79-14-W4.
[2]The number in brackets is the number of stands which comprise that particular cover type.
SOURCE: Timber Management Branch, Alberta Forest Service.

LEGEND

A - Populus tremuloides (Aspen)

P - Pinus banksiana (Jackpine)

Sb - Picea mariana (Black Spruce)

Sw - Picea glauca (White Spruce)

Bw - Betula papyrifera (White Birch)

Fb - Abies balsamea (Balsam Fir)

BU - Burned in 1978

CS - Coniferous Scrub

DS - Deciduous Scrub

OM - Open Peatland (Muskeg)

TM - Treed Peatland (Muskeg)

WA - Water

FL - Flooded

BIBLIOGRAPHY

Achuff, P.L. 1974. "Spruce-fir forests of the highlands of northern Alberta." Unpublished Ph.D. thesis. University of Alberta, Edmonton.

Achuff, P.L. and G.H. La Roi. 1977. Picea - Abies forests in the highlands of northern Alberta. Vegetatio 33: 127-146.

Alberta. Forest Service. 1983. Unpublished Phase 3 Forest Inventory Data (Scale 1:15,000) for Crow Lake area. Department of Energy and Natural Resources. Edmonton.

Alberta. Fish and Wildlife Division. n.d. "Furbearer catches on registered traplines in the Athabasca tar sands region, 1973-1982." Department of Energy and Natural Resources. Unpublished data.

Alberta. Fish and Wildlife Division. 1975. "Moose and wolf survey, Athabasca River. Dornier 28-B1." Department of Energy and Natural Resources. Unpublished data.

Alberta. Fish and Wildlife Division. 1981. Wildlife Key Area Maps, Pelican 83P, Winefred Lake 73 M. Department of Energy and Natural Resources. Edmonton.

Alberta Land Inventory. n.d. Map 83 P/9 and 83 P/16. Soil Capability for Agriculture -- 1:63,360 Map Series. Alberta Energy and Natural Resources. Edmonton.

Alberta Oil Sands Environmental Research Program. 1976. Annual reports for A.O.S.E.R.P. Subproject Ungulates, TF 1.1.

Alberta Oil Sands Environmental Research Program. 1979. Distribution, abundance and habitat associations of beavers, muskrats, mink and river otters in the A.O.S.E.R.P. study area, northeastern Alberta. Project LS 23.2.

Alberta Oil Sands Environmental Research Program. 1980. Small mammal populations of northeastern Alberta. I. Populations in natural habitats. Project LS 7.1.2.

Argus, G.W. and D.J. White. 1978. The rare vascular plants of Alberta. National Museum of National Sciences, Syllogeus Series No. 17.

Atmospheric Environment Service. 1982. Canadian Climate Normals, 1951-1980. Vol. 1-6. Environment Canada. Downsview.

Banfield, A.W.F. 1974. The mammals of Canada. University of Toronto Press, Toronto.

Beaver, R. 1977. Surveys of rare, potentially endangered and sensitive birds in the Oil Sands and adjacent areas of northeastern Alberta. Canadian Wildlife Service, Environment Canada.

Bradley, G.M. 1969. Preliminary biological survey of six lakes in northern Alberta. Fish and Wildlife Division, Alberta Department of Lands and Forests. Edmonton.

Canada Land Inventory. 1971a. Map 83P, Land Capability for Recreation - 1:250,000 Series. Department of the Environment. Ottawa.

Canada Land Inventory. 1971b. Map 83P, Land Capability for Forestry - 1:250,000 Series. Department of the Environment. Ottawa.

Canada Land Inventory. 1975. Land capability for wildlife-ungulates. Pelican map sheet 83P. Environment Canada.

Canada Land Inventory. 1979. Land capability for wildlife - waterfowl. Pelican map sheet 83P. Environment Canada.

Canada Soil Survey Committee. 1978. The Canadian System of Soil Classification. Canada Department of Agriculture. Publication 1646. Ottawa.

Carrigy, M.A. 1973. "Mesozoic geology of the Fort McMurray area." In: Guide to the Athabasca Oil Sands Area, ed. M.A. Carrigy, 79-101. Alberta Research Council, Information Series 65.

Carroll, S.B. and L.C. Bliss. 1981. Jack pine - lichen woodland on sandy soils in northeastern Alberta. Canadian Journal of Botany 60: 2270-2282.

Chalmers, J.W. 1974a. "Wayfaring, airborne and earthbound." In: The Land of Peter Pond, ed. J.W. Chalmers. Boreal Institute for Northern Studies. Edmonton.

Chalmers, J.W. 1974b. "A century of the fur trade." In: The Land of Peter Pond, ed. J.W. Chalmers. Boreal Institute for Northern Studies. Edmonton.

Crum, H.A., W.C. Steere, and L.E. Anderson. 1973. A new checklist of mosses of North America north of Mexico. Bryologist 76:85-130.

Daubenmire, R. 1959. A canopy-coverage method of vegetation analysis. Northwest Science 33:43-64.

Ellis, B. and G.H. La Roi. 1978. Unpublished stand check sheet (Releve No. 14) for Crow Lake. Alberta Ecological Survey.

Fairbarns, M. 1979a. Northeastern Alberta: a park resource assessment study. Part 1: regional overview. Parks Planning, Alberta Recreation and Parks. Edmonton.

Fairbarns, M. 1979b. Northeastern Alberta: a park resource assessment study. Part 2: recreation and preservation recommendations. Parks Planning, Alberta Recreation and Parks. Edmonton.

Fuller, W.A., G.H. La Roi, and P.W. Stringer. 1970. Unpublished letter to the Natural Areas Committee from the Alberta I.B.P. Consulting Panel, April 16, 1970.

Gravenor, C.P. and L.A. Bayrock. 1961 Glacial deposits of Alberta. Research Council of Alberta, Contribution No. 151.

Gravenor, C.P. and W.A. Meneley. 1958. Glacial flutings in central and northern Alberta. American Journal of Science 256: 715-728.

Green, R. 1972. Geological map of Alberta, scale 1:1,267,000. Alberta Research Council. Edmonton.

Griffiths, W.E. and D.B. Ferster. 1974. Preliminary fisheries survey of the Winefred-Pelican area. Fish and Wildlife Division, Alberta Lands and Forests. Edmonton.

Gunderson, G. and B. Rippen. 1978. Athabasca River moose survey, March 6, 1978. Fish and Wildlife Division, Alberta Recreation, Parks and Wildlife. Edmonton. Unpublished data.

Gunderson, G. and B. Rippen. 1981. Moose survey - Winefred Lake, Christina River and Gregoire Lake areas, January 26-29, 1981. Fish and Wildlife Division, Alberta Energy and Natural Resources. Edmonton. Unpublished data.

Hackbarth, D.A. and N. Nastasa. 1979 The hydrogeology of the Athabasca Oil Sands area. Alberta Research Council, Bulletin 38. Edmonton.

Hale, E. Jr. and W.L. Culberson. 1970. A fourth checklist of the lichens of the continental United States and Canada. Bryologist 73: 499-543.

Hall, W.K., J.A. Bibaud, and T. Archer 1974a. Major river survey of map sheets 84A, G, M, N, 73M, and 83P. Fish and Wildlife Division, Alberta Department of Lands and Forests. Edmonton. Unpublished data.

Hall, W.K., J.A. Bibaud, and T. Archer. 1974b. Ungulate survey of map sheets 84G, A, 83P, 73M. Township lines (Athabasca - MacKenzie pipeline corridor). Fish and Wildlife Division, Alberta Department of Lands and Forests. Edmonton. Unpublished.

Horton, D.G., D.H. Vitt, and N.G. Slack. 1979. Habitats of circumboreal - subarctic sphagna: I. A quantitative analysis and review of species in the Caribou Mountains, northern Alberta. Canadian Journal of Botany 57: 2283-2317.

Ireland, R.R., C.D. Bird, G.R. Brassard, W.B. Schofield, and D.H. Vitt. 1980. Checklist of the mosses of Canada. National Museums of Canada, Publications in Botany No. 8.

James, S.A. 1980. "What's your hurry, Fort McMurray?: the physical development of the Oil Sands town." Unpublished B.A. Thesis. Carleton University, Ottawa.

Jeglum, J.K. 1971. Plant indicators of pH and water level in peatlands at Candle Lake, Saskatchewan. Canadian Journal of Botany 49: 1661-1676.

Jeglum, T.K., C.F. Wehrhahn, and J.M. Swan. 1971. Comparisons of environmental ordinations with principal component vegetational ordinations for sets of data having different degrees of complexity. Canadian Journal of Forest Research 1: 99-112.

Kabzems, A., A. Kosowan, and W. Harris. 1976. Mixedwood section in an ecological perspective: Saskatchewan. Forestry Branch, Technical Bulletin 8. Saskatchewan Department of Tourism and Renewable Resources.

Lacate, D.S. 1969. Guidelines for biophysical land classification. Canadian Forest Service, Publication 1264. Department of the Environment. Ottawa.

Laidlaw, T. and R. Hnatiuk. 1969. I.B.P. check sheet of survey of Crow Lake. International Biological Programme. Unpublished data.

La Roi, G.H. 1967. Ecological studies in the boreal spruce-fir forests of the North American taiga. I. Analysis of the vascular flora. Ecological Mongraphs 37: 229-253.

La Roi, G.H. and T.A. Babb. 1974. Terminal report of the Alberta C.T. Consulting Panel. Canadian Committee for the International Biological Programme: Conservation of Terrestrial Biological Communities Subcommittee. Region 2, Alberta.

Lee, P., D. Gilmore, and P. McIsaac. 1979. Natural Areas survey report for Crow Lake. Natural Areas Program, Alberta Energy and Natural Resources. Unpublished data.

Longley, R.W. and B. Janz. 1978. The climatology of the Alberta Oil Sands Environmental Research Program study area. Alberta Oil Sands Environmental Research Program, Report No. 39.

Looman, J. and K.F. Best. 1979. Budd's Flora of the Canadian Prairie Provinces. Agriculture Canada Research Branch, Publication 1662.

McCullough, E.J. 1982. Prehistoric cultural dynamics of the Lac La Biche Region. Archeological Society of Alberta, Occasional Paper No. 18.

McPherson, K. 1977. Surficial geology of the potential mining areas in the Athabasca Oil Sands region. Alberta Research Council, Open File Report 1977-4.

Moss, E.H. 1953. Forest communities in northwestern Alberta. Canadian Journal of Botany 31: 212-252.

Moss, E.H. 1953. Marsh and bog vegetation in northwestern Alberta. Canadian Journal of Botany 31: 448-470.

Moss, E.H. 1955. The vegetation of Alberta. Botanical Review 21: 493-567.

Moss, E.H. 1959. Flora of Alberta. University of Toronto Press, Toronto.

Moss, E.H. 1983. Flora of Alberta. Second Edition revised by J.G. Packer. University of Toronto Press, Toronto.

Norris, A.W. 1973. "Paleozoic (Devonian) geology of northeastern Alberta and northwestern Saskatchewan." In: Guide to Athabasca Oil Sands Area, ed. M.A. Carrigy, 17-61. Research Council of Alberta, Information Series 65.

Novak, M. 1969. Distribution and abundance of some big game animals in northeast Alberta during winter of 1967-68. Fish and Wildlife Division, Alberta Department of Lands and Forests. Edmonton. Unpublished data.

Ozoray, G.F. 1974. Hydrogeology of the Waterways - Winefred Lake Area, Alberta. Alberta Research Council, Report 74-2.

Ozoray, G. and A.T. Lytviak. 1980. Hydrogeology of the Pelican-Algar Lake area, Alberta. Alberta Research Council, Earth Sciences Report 80-1.

Packer, J.G. and C. Bradley. 1984. "A checklist of the rare vascular plants in Alberta." Provincial Museum of Alberta, Natural History Paper No. 5.

Pettapiece, W. n.d. "Provisional physiographic map of Alberta." Unpublished.

Pollock, J. 1977. "Archaeological site inventory data." Alberta Archaeological Survey, Borden No. GK Pa-2. Unpublished data.

Raup, H.M. 1946. Phytogeographical studies in the Athabasca - Great Slave Lake Region, II. Journal of the Arnold Arboretum 27: 1-85.

Rintoul, J. and S. Myers. 1983. Avifauna of Crow Lake candidate ecological reserve - observed and expected. Natural Areas Program, Alberta Energy and Natural Resources. Natural Areas Technical Report No. 10.

Rowe, J.S. 1961. Critique of some vegetational concepts as applied to forests in northwestern Alberta. Canadian Journal of Botany 39: 1007-1017.

Rowe, J.S. and G.W. Scotter. 1973. Fire in the boreal forest. Quaternary Research 3: 444-464.

Renewable Resources Consulting Services Ltd. 1974. Phase 1 - Wildlife. Northeast Alberta Regional Plan Project, Report A12.

Renewable Resources Consulting Services Ltd. 1975a. Furbearers. Northeast Alberta Regional Plan Project, Report A13.

Renewable Resources Consulting Services Ltd. 1975b. Rare and endangered species. Northeast Alberta Regional Plan Project, Report A14.

Renewable Resources Consulting Services Ltd. 1975c. Vegetation characteristics in northeastern Alberta. Northeast Alberta Regional Plan Project, Report A11.

Rubec, C.D. and E.C. Pollet (ed.). 1979. Proceedings of a workshop on Canadian Wetlands. Lands Directorate. Ecological Land Classification Series No. 12. Environment Canada.

Salt, W.R. and J.R. Salt. 1976. The birds of Alberta. Hurtig Publishers, Edmonton.

Scott, W.B. and E.J. Crossman. 1973. Freshwater fishes of Canada. Fisheries Research Board of Canada, Bulletin 184. Environment Canada. Ottawa.

Sjörs, H. 1963. Bogs and fens on Attawapiskat River, northern Ontario. National Museums of Canada, Bulletin 186: 45-133.

Story, B., K. Froggatt, and B. Hall. 1976. "Pelican Portage - House River Moose Survey." Fish and Wildlife Division, Alberta Recreation, Parks and Wildlife. Edmonton. Unpublished data.

Stotler, R. and B. Crandall-Stotler. 1979. A checklist of liverworts and hornworts of North America. Bryologist 80: 405-429.

Strong, W.L. and K.R. Leggat. 1981. Ecoregions of Alberta. Alberta Energy and Natural Resources, Edmonton. Technical Report No. T14.

Todd, A.W. and L.C. Geisbrecht. 1979. A review of Alberta fur production and management, 1920-21 to 1977-78. Fish and Wildlife Division, Alberta Energy and Natural Resources. Edmonton.

Turner, W.R. 1968. "Preliminary biological survey of Wabasca Lakes area, 1967." Fish and Wildlife Division, Department of Lands and Forests. Edmonton. Unpublished data.

van Groenewoud, H. 1965. An analysis and classification of white spruce communities in relation to certain habitat features. Canadian Journal of Botany 43: 1025-1036.

Vitt, D.H., P. Achuff, and R.E. Andrus. 1975. The vegetation and chemical properties of patterned fens in the Swan Hills, northcentral Alberta. Canadian Journal of Botany 53: 2776-2795.

Vitt, D.H. and R.E. Andrus. 1977. The genus Sphagnum in Alberta. Canadian Journal of Botany 55: 331-357.

Walmsley, M., G. Utzig, T. Vold, D. Moon, and J. Van Barneveld (eds.). 1980. Describing Ecosystems in the field. R.A.B. Technical Paper 2, Land Management Report No. 7. Research Branch, Ministry of Forests and Resource Analysis Branch, Ministry of Environment. Province of British Columbia, Victoria.

Williams, A. 1981. Unpublished memo to file from A. Williams Minerals Geologist, concerning geology of Crow Lake area.

Wynnyk, A., J.D. Lindsay, P.K. Heringa, and W. Odynsky. 1956. Exploratory soil survey of Alberta map sheets 83-O, 83-P and 73-M. Research Council of Alberta. Preliminary Soil Survey Report 64-1.